Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors:

A research report for Marine Scotland

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1 Executive Summary

Background

In 2018, Marine Scotland recognised a need to identify whether there is scope to improve the economic growth of the UK's marine sectors, and to understand whether the benefits of growth are naturally distributed fairly across society now and in the future. A research project "Supporting the Economic, Social and Environmental Sustainability of the UK's Marine Sectors" was commissioned in early 2019 to review this question.

Aims and Objectives

The report aims to provide an evidence base to help guide policies to ensuring the economic, social and environmental sustainability of the UK's marine economic sectors, including:

- Commercial capture fishing (including sea fisheries and key inland fisheries)
- Aquaculture (including fish and shellfish cultivation)
- Seafood processing
- Commercial seaweed harvesting and growing
- Marine renewable energy
- Oil and gas decommissioning
- Marine tourism

The evidence collected is intended to guide policy in how best to support the sustainable growth of the different industry sectors in a strategic and streamlined way. This is required to increase understanding of the constraints and market failures facing the UK's marine industries with respect to delivering inclusive growth, building resilient places, improving sustainability and enabling net zero emissions.

The research aims to:

A. Provide a sectoral overview and analysis of long term growth patterns for each of the marine sectors listed above, for the UK and each devolved administration (DA).

B. Identify evidence for market failures and other constraints that hinder the long term growth, wider distribution of benefits and environmental sustainability of the UK's marine sectors.

C. Identify the existing support measures currently available to the UK's marine sectors (including organisations delivering them).

Key Findings

The research report recognises the important role the marine economy plays in driving growth in coastal areas as well as across Scotland and the UK though wider supply chains. A number of sectors within the marine economy are in a strong position thanks to concerted efforts, favourable markets and effective government regulation and intervention. There is potential for further growth; sectors vary in levels of maturity, specific barriers faced and whether those are market failures or competitive pressures.

As well as sectoral specific barriers, the research identified a number of challenges and constraints which are shared across the marine economy, these can be summarised in the following themes:

- Skills and workforce
- Sustainable and shared marine natural capital
- Infrastructure
- Technology, data and innovation
- Access to finance
- Resilient communities
- Monitoring and evidence-based decisions

These themes are discussed in more detail in Chapter 5 within the report.

Overall sector assessments based on the detailed research and analysis carried out as part of the project, are presented below.

Figure 2.2: At-a-glance sector assessment for commercial capture fishing

	Business base	Employment	Turnover/ landing	GVA	Trade	Impact distribution
UK	++	+	++	++	+	-
England	++	++	++	++	N/A	-
Northern Ireland	-	-	-	++	N/A	-
Scotland	++	+	++	++	N/A	-
Wales	++	--	++	++	N/A	-

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

Figure 2.3: At-a-glance sector assessment for aquaculture

	Business base	Employment	Turnover	GVA	Trade[1]	Impact distribution
UK	+	-	++	++	++	-
England	+	--	++	++	N/A	-
Northern Ireland	+	N/A	+	+	N/A	+
Scotland	++	++	++	++	++*	+
Wales	+	-	+	+	N/A	-

Figure 2.4: At-a-glance sector assessment for seafood processing

	Business base	Employment	Turnover*	GVA	Trade*	Impact distribution
UK	--	++	+	++	--	-
England	-	++	+	++	N/A	-
Northern Ireland	--	++	--	++	N/A	-
Scotland	--	+	++	++	N/A	-
Wales	+	+	+	++	N/A	--

Figure 2.7: At-a-glance sector assessment for commercial seaweed harvesting

	Business base	Employment	Turnover	GVA	Trade	Impact distribution
UK	+	N/A	N/A	N/A	N/A	+
England	N/A	N/A	N/A	N/A	N/A	+
Northern Ireland	N/A	N/A	N/A	N/A	N/A	+
Scotland	N/A	N/A	N/A	N/A	N/A	+
Wales	N/A	N/A	N/A	N/A	N/A	+

Figure 2.13: At-a-glance sector assessment for offshore renewables

	Business base*	Employment*	Turnover	GVA	Trade	Impact distribution
UK	++	++	++	++	-	+
England	++	+	++	N/A	--	+
Northern Ireland	+	+	++	N/A	+	+
Scotland	+	++	++	N/A	++	+
Wales	+	-	-	N/A	--	+

[1] Assessment for Scotland based on Scottish salmon export data only

Figure 2.17: At-a-glance sector assessment for oil & gas decommissioning

	Business base+	Employment+	Turnover*	GVA	Trade#	Impact distribution
UK	--	-	++	--	--	-
England	--	--	N/A	N/A	N/A	+
Northern Ireland	-	N/A	N/A	N/A	N/A	--
Scotland	--	-	N/A	N/A	N/A	+
Wales	-	--	N/A	N/A	N/A	--

Figure 2.20: At-a-glance sector assessment for marine tourism

	Business base	Employment	Turnover	GVA	Trade	Impact distribution
UK	N/A	+	++	++	++	+
England	N/A	+	N/A	N/A	N/A	+
Northern Ireland	N/A	+	N/A	N/A	N/A	+
Scotland	N/A	++	++	++	++	+
Wales	N/A	+	N/A	N/A	N/A	+

Implications

The challenges and constraints identified through this research will not be overcome by business alone, nor by government if using a solely sectoral approach. These challenges require a strategic approach from multiple areas across government, local authorities and enterprise agencies.

The economic, social, political and environmental backdrop has changed since this research was carried out. Uncertainties around EU exit remain but Covid19 has created an unprecedented shock which is not yet fully understood nor is fully behind us yet. This research report provides a strong base for guiding decisions on future funding and policy relating to the marine economy, further research and ongoing monitoring is required to understand the implications of Covid19 and the end of the transition period for EU Exit.

2 Introduction

Overview

2.1 ekosgen was commissioned by Marine Scotland in January 2019 to develop an evidence base for the UK's marine economy, to inform the preparation of future support mechanisms for marine sector activity. Central to this was an exploration of the economic, social and environmental sustainability of seven of the UK's marine sectors. For the purposes of this research, these sectors are:

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

2.2 Future financial or technical support mechanisms must address any potential scope to maximise the economic growth of the UK's marine sectors, as well as ensuring that the benefits of growth are distributed fairly across society to be enjoyed by future generations. Consequently, evidence was required on the market failures and economic growth constraints facing the seven sectors. The evidence provided in this report is intended to guide policy in how best to support the sustainable growth of the different sectors in a strategic and streamlined way.

Objectives

2.3 Broadly, the research aimed to provide an evidence base to help guide policies to ensure the economic, social and environmental sustainability of the seven marine economic sectors identified. The key objectives of the research as set out by Marine Scotland were:

- Provide a sectoral overview and analysis of long term growth patterns of each UK marine sector and in each UK country, with consideration for trends and benchmarking across comparable countries where relevant. This included analysis of output, GVA, labour productivity, employment, trade patterns and distribution of impacts from the industry;
- Identify market failures and non-legislative constraints that hinder growth and the wider distribution of benefits and environmental sustainability, with specific geographic and sectoral evidence of failures and constraints highlighted;

- Provide an overview of existing support measures, mapping sources, levels and types of support (such as financial or technical) that are available to each marine sector across the UK; and
- Identify priority areas for future action.

Approach

2.4 The approach to the study has incorporated desk research around market failures, constraints and sectoral contextualisation, as well as consultations and workshops with key industry figures. Specifically, the research included:

- Desk review of market failures and constraints, and a subsequent report;
- Industry/informant workshops held in Belfast, Cardiff and Newcastle, and consultations with 31 key industry stakeholders from across England, Northern Ireland, Scotland and Wales;
- Baseline socio-economic analysis of the seven key UK marine sectors; and
- Development of a support mechanism framework mapping financial, technical and other support sources available to businesses and actors across the seven marine sectors.

Research challenges

2.5 The research contended with a number of significant challenges, largely related to the engagement of key stakeholders. In a number of instances, this research coincided with other research and consultation programmes being undertaken at a UK level, or within the devolved administrations, such as the Welsh Government's *Brexit and Our Seas* consultation. Indeed, Brexit preparations have had a considerable impact on the availability of partners and stakeholders.

2.6 Further, many stakeholders have been extensively consulted in recent years, e.g. on skills issues in aquaculture, or on the development of Science and Innovation Audits (SIAs) as part of the UK Government's Industrial Strategy. As such, there is a high degree of consultation and survey fatigue amongst stakeholders, resulting in a reluctance to participate in further research. Relevant findings from these commissions have been incorporated into the desk based review element of this work, and reflected appropriately in this report.

2.7 Finally, some more practical factors have impacted on the availability of consultees. Day job commitments have served to limit the availability of senior staff within organisations. Additionally, geographical factors presented challenges for stakeholders invited to participate in workshops – a particular challenge in Scotland for a relatively disparate group of stakeholders, which ultimately meant that a workshop in Scotland was not possible.

Report structure

2.8 The report is structured as follows:

- **Chapter 2** sets out an overview of each of the seven UK marine sectors, accounting for the performance of each sector, as well as successes and challenges;
- **Chapter 3** draws on the primary and secondary research undertaken to examine the challenges and constraints of each sector, considering challenges around human, environmental/natural, infrastructure, financial, technological, political and community/social capital;
- **Chapter 4** provides an overview of existing support mechanisms, identifying the main mechanisms across the EU, UK and national/devolved/local levels and any gaps or issues around support mechanisms; and
- **Chapter 5** highlights priority and action areas, including suggested strategic actions for the future.

2.9 A number of appendices accompany this report and are available under Supporting Documents:

- **Appendix 1** sets out the in-depth sector baseline analyses;
- **Appendix 2** contains the detailed literature review;
- **Appendix 3** maps the existing financial and technical support mechanisms available to businesses and actors in marine sectors; and
- **Appendix 4** sets out the list of consultees.

Overview boxes

2.10 Throughout the report, in relation to each of the seven marine sectors, 'at-a-glance' summary boxes are used to provide an overview with respect to the economic baseline or constraints and challenges for each sector.

2.11 Each at-a-glance summary box provides an assessment at the UK level, and also for each country where data allow. The assessment uses a colour-coded scheme to indicate the performance of each sector (Figure 1.1), and the degree to which constraints and challenges impact on each sector (Figure 1.2).

2.12 For the economic baseline, each sector is assessed against different economic measures (e.g. employment, turnover, etc.). The growth of each sector across each of these measures is assessed in absolute terms across the time period in question (e.g. 2013-17), rather than in comparison with other sectors' performance or with that of the economy as a whole, and is informed by the consultants' expert judgement arising from the data analysis.

Figure 1.1: Example at-a-glance sector economic baseline assessment summary box

	Business base	Employment	Turnover	GVA	Trade	Impact distribution
UK						
England						
Northern Ireland						
Scotland						
Wales						

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

2.13 For constraints and challenges, each sector is assessed against broad categories or 'capitals'.

Figure 1.2: Example at-a-glance sector constraints assessment box

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK							
England							
Northern Ireland							
Scotland							
Wales							

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

2.14 The assessment is based on the consultants' expert judgement, drawing from the analysis of the nature of constraints and challenges identified through this research.

2.15 It should be noted that the at-a-glance assessments are not intended to provide a definitive verdict, but rather to illustrate economic performance or constraints to growth.

3 Overview of marine sectors in the UK

Introduction

3.1 This chapter provides an overview of the economic performance of each of the seven sectors of the marine economy within scope for this research study. It draws on the detailed analysis presented in Appendix 1, available in the Supporting Documents, the structure of which was agreed with the project's Steering Group.

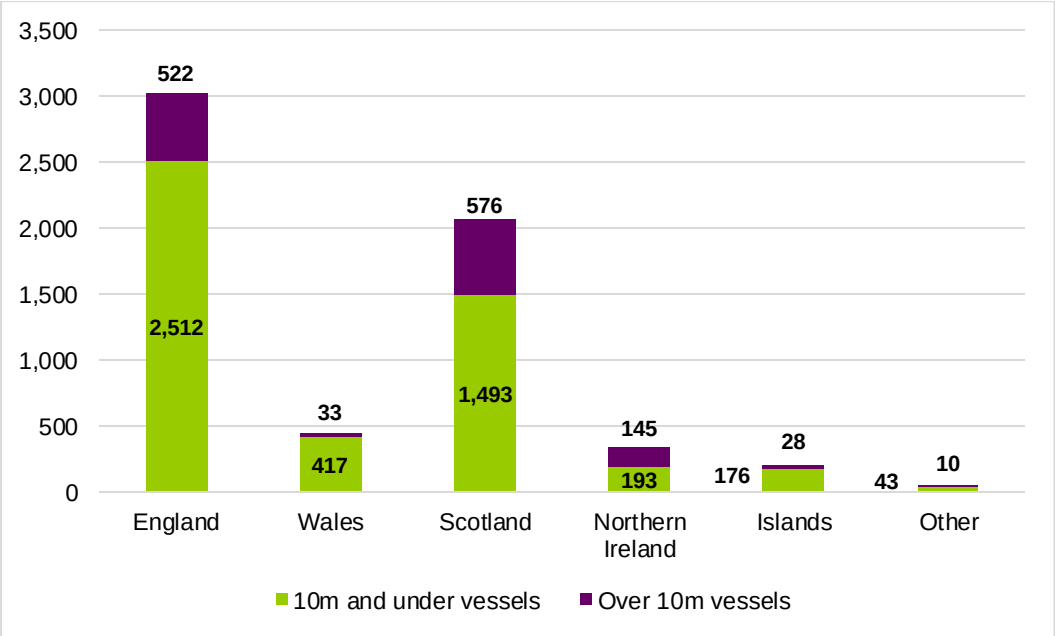
3.2 For each sector, consideration is given to the sector's economic performance in recent years, before an examination of the outlook for the sector in line with strategic growth aspirations.

Commercial capture fishing

3.3 The commercial capture fishing sector comprised almost 6,150 vessels in 2017. As illustrated in Figure 2.1 it is dominated by the fleets in England and Scotland, which account for over 80% of vessels. Whilst England has the highest number of vessels overall, Scotland has the greatest number of vessels over 10m in its fleet (accounting for 28% of the total fleet).

3.4 The industry is relatively geographically concentrated. In England, the sector is largely located in the South West (Devon and Cornwall), and in the North East (Humberside, Tyneside). In Scotland, the sector (by both number of vessels and tonnage) is predominantly located in NE Scotland and Shetland, with the majority of the remainder of operations on Scotland's west coast. In Wales, fishing operations are largely in the South West, around Pembrokeshire, or in the North West and specifically Holyhead; in Northern Ireland, the industry is concentrated in the ports of Belfast, Kilkeel, Portavogie and Ardglass.

Figure 2.1: Size of the UK fishing fleet, by country of administration[2]



MMO (2018) UK Sea Fisheries Statistics, 2017

3.5 As Figure 2.2 illustrates, the commercial capture fishing industry in the UK has seen reasonable growth in recent years, in terms of business base, turnover and GVA. However, there has been a decrease in employment[3] at the UK level, with only England showing any significant employment growth. Impact distribution is also constrained because of the geographic concentration of the industry across the UK.

Figure 2.2: At-a-glance sector assessment for commercial capture fishing

	Business base	Employment	Turnover/ landing	GVA	Trade	Impact distribution
UK	++	+	++	++	+	-
England	++	++	++	++	N/A	-
Northern Ireland	-	-	-	++	N/A	-
Scotland	++	+	++	++	N/A	-
Wales	++	--	++	++	N/A	-

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	Key	++	Strong growth; widespread distribution of impacts	+

[2] Islands include Guernsey, Jersey and Isle of Man. Other typically includes new vessels, or vessels switching port of administration.

[3] Employment refers only to full-time and part-time staff, i.e. excluding contractors

Sector performance

3.6 **There has been modest turnover growth in the UK's commercial capture fishing sector in recent years**. Total business turnover has increased by just over 3% to £1bn between 2013 and 2017.[4]

3.7 **The value of landed fish has seen strong growth**. The total value of fish landed between 2013 and 2017 by UK vessels has grown by around 32%. At the same time, the Landed Price Index[5] has increased from 153.9 to 182.9 (versus 2000 prices) over the same period. This increased value of catch means that in 2017, fish worth around £980m was landed by UK vessels.

3.8 **The total tonnage of landed fish has also seen strong growth between 2013 and 2017**. 2017 landings stood at 724,330 tonnes, and increase of 16% on 2013 figures. Landings by species type vary by each country of the UK. Landings by vessels administered in Scotland in 2017 were broadly evenly split between demersal, pelagic and shellfish, with pelagic accounting for a slightly higher proportion by weight, (35%; this rises to 44% when considering value of landings at Scottish ports). In contrast, demersal species account for the largest proportion of English vessel landings at 50% (though only 30% by value at English ports). Landings for both Northern Ireland and Wales are dominated by Shellfish – for Wales in particular, this is largely made up by Whelks; in Northern Ireland, nephrops are the highest represented species in terms of landings.[6]

3.9 **In terms of GVA, there has been strong growth**: the sector's added contribution was estimated at £566m in 2017 – growth of around 49% since 2013.[7] GVA per worker at the UK level stood at almost £168,000 in 2017.[8] Whilst no historic figures are available for Northern Ireland to allow for a UK-wide comparison, evidence from elsewhere in the UK indicates that GVA per worker has grown strongly – by 25% in England, 38% in Scotland, and 67% in Wales in the period 2012-17.

3.10 **The trade deficit in fishing persists**. During the period 2013-17, this fluctuated but with very little substantial change: exports have grown by around 30%, but this is insufficient to offset at 16% growth in imports. As a result, net imports stood at just over £1.29bn in 2017.[9] Anecdotal as well as balance sheet evidence[10] suggest that this is in part due to patterns of consumption in the UK – there is dissonance between what is caught by UK vessels, and what is consumed by the UK population.

[4] ONS, 2018

[5] MMO (2018) UK Sea Fisheries Statistics, 2017

[6] Ibid., Chapter 3

[7] Ibid.

[8] MMO (2018) UK Sea Fisheries Statistics, 2017

[9] Ibid., Chapter 4

[10] Ibid., Chapter 6

3.11 **The commercial capture fishing business has seen modest growth in recent years**. The fishing business base has increased by 4% between 2012 and 2017, with the largest absolute and proportional growth in Scotland. Northern Ireland's fishing base contracted by around 3% over the period, with Wales's business base remaining largely stable.

3.12 **However, the commercial capture fishing workforce has contracted**. In contrast to the business base, the UK workforce has decreased by 8% over the same period, from around 7,000 to just under 6,500. The largest proportional decrease was in Wales, with the employment base contracting by almost 47%. In contrast, England's fishing workforce increased by 7% (+125).[11] At the UK level this suggests a trend towards smaller companies or self-employment, with some degree of workers exiting the sector.

3.13 **The UK's fishing fleet has contracted**. 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. Indeed, anecdotal and industry evidence suggests that there has been an increase in vessel-building activity in recent years. However, over the period 2014 to 2017, there has been a decrease of around 4% in the UK's fleet size. Only Scotland has seen an increase, of just over 1% since 2014.[12]

Sector outlook

3.14 Evidence suggests that the commercial capture fishing sector is reasonably healthy, and it is growing sufficiently to meet (or contribute to meeting) a number of broad strategic targets set across the countries of the UK. For example:

- **Seafood 2040 (England)**: There is ambition to increase seafood consumption in England by 75% – and thus increase employment in fisheries to 5,300, and fisheries sales to £504m by 2040. Evidence from the value of landings indicates that the rate of landings growth is sufficient to reach this target well before 2040. However, the employment target may not be met. There is an average annual growth rate in employment of around 5%, which would be sufficient to meet the employment target by 2037; but this masks a decrease of 42% between 2016 and 2017. Assuming a similar growth pattern to 2040, this would be insufficient to meet the employment target.
- **Wales Seafood Strategy**: The strategy aims to grow fisheries production and turnover by 30%, and employment in fisheries by 10% by 2025. As demonstrated above, employment targets are unlikely to be met if current growth patterns persist. Further, the fisheries production target would not be met; however, the increase in the value of landed catch in Wales indicates that, if current trends are maintained, the 30% increase target could be met as early as 2020.

[11] ONS, 2018

[12] MMO (2018) UK Sea Fisheries Statistics, 2017, Chapter 2

- **Ambition 2030 (Scotland)**: There is a wider ambition to double the value of Scottish Food & Drink to £30bn, of which fisheries is a key part. For fisheries, this would assume a doubling of the value of landed catch to £1.12 billion by 2030. Assuming that the current pattern of growth persists, this target would be met four years early, by 2026.

3.15 Whilst production, sales or turnover targets appear achievable, recent decreases in employment raise questions regarding the achievability of employment targets in England. However, the main focus for all strategies and plans regarding fisheries is the *sustainability* of stocks and fishing operations.

Commercial capture fishing in Iceland and Norway

3.16 Commercial capture fishing is a key component of Iceland's economy. It is regarded as the second largest fisheries nation in the North East Atlantic, behind Norway. It employs around 2% of Iceland's total workforce, though in recent years, the workforce has declined. Between 2013 and 2017, the workforce declined by around 18%. In terms of catch, the tonnage and value of landed fish has declined. In 2017, a total of 1.18 million tonnes of fish was landed by the Icelandic fleet, a decrease of around 14% since 2013. In value terms, this amounted to around Kr 11bn (£1.03bn), a decrease of over 17%.[13] It is worth noting that catch in 2017 was influenced by a fisherman's strike over pay and conditions.

3.17 Fishing is a major industry in Norway. However, Norway's fishing workforce has also decreased somewhat in recent times, though this decrease is smaller than in Iceland or the UK. In 2017, the workforce totalled 11,320, a decrease of around 2.5%. Norway's fleet has remained broadly the same over the period 2013-17, though this masks a small decrease in 2014 and 2015. However, in contrast to Iceland, the total tonnage landed increased 15% to 2.4 million tonnes between 2013 and 2017, with a corresponding increase in value of almost 43%. This is in excess of the growth in tonnage and value of the UK. This indicates that Norway's commercial capture fishing sector is increasing in productivity and efficiency, helping to consolidate its market share in the North East Atlantic.

3.18 Whilst the downward trend in employment in commercial capture fishing appears to be the norm across major fisheries in the North East Atlantic, there are some clear differences in catch between countries. The evidence demonstrates that whilst the UK's commercial capture fishing sector has grown in recent years, its ability to grow further and secure a greater market share is arguably dependent on its ability to increase its productivity. The growth challenge here is one of competitiveness to increase the UK's market share in the North East Atlantic.

[13] Statistics Iceland, 2019

Aquaculture

3.19 The aquaculture industry has seen significant growth in recent years. Aquaculture is of particular significance to the economic growth in 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. The majority of UK aquaculture activity is located in Scotland where finfish production dominates, although it is increasing in areas of Wales and England, with shellfish aquaculture being spread more evenly throughout the countries of the UK although it is less well developed. In Scotland, aquaculture is relatively mature and vertically integrated, finfish in particular.

3.20 As Figure 2.3 demonstrates, available data shows that there has been reasonably strong growth across some aspects of the aquaculture sector, certainly with regard to turnover and GVA. However, there has been a decrease in employment at the UK level, and weak growth in the business base – though this is in part due to consolidation in the sector. As aquaculture is relatively confined to rural and remote coastal areas, the distribution of impacts is relatively narrow.

Figure 2.3: At-a-glance sector assessment for aquaculture

	Business base	Employment	Turnover	GVA	Trade[14]	Impact distribution
UK	+	-	++	++	++	-
England	+	--	++	++	N/A	-
Northern Ireland	+	N/A	+	+	N/A	+
Scotland	++	++	++	++	++*	+
Wales	+	-	+	+	N/A	-

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

3.21 This is discussed in more detail in the following sections. Further analysis is presented in Appendix 1, available as a Supporting Document.

Sector performance

3.22 **Turnover in the UK aquaculture sector has grown strongly in recent years.** In 2017, the turnover of the UK aquaculture sector was £1.3bn, an increase of 47% since 2013, with growth particularly concentrated between 2016 and 2017 where turnover rose by £343m or 36%.[15] Scotland accounts for a disproportionate

[14] Assessment for Scotland based on Scottish salmon export data only

[15] ONS, 2018

amount of aquaculture turnover, reflecting its strength in the industry. In 2016, Scottish aquaculture turnover accounted for 84% of total UK turnover despite Scotland only accounting for 8% of the UK population.[16] Turnover of Scottish aquaculture more than doubled between 2012 and 2016, reaching £797m. Scotland therefore plays a particularly prominent role to play in the aquaculture industry across the UK.

3.23 **Evidence indicates that aquaculture trade has also increased**. While there is no trade data available for aquaculture on its own, fishing and aquaculture exports has grown over the period 2013-17. Following a fall in exports from 2014 to 2015, total export value rose to £738m in 2017, an overall growth of £295m or 67% since 2013.[17] Import values to 2017 are incomplete, with data being withheld by ONS for disclosure control. However, previous datasets to 2016 indicate that import values around the £40m mark.[18]

3.24 Given the predominance and maturity of Scottish finfish aquaculture and salmon in particular, data are available for salmon exports. Across a similar time period, the UK has seen significant growth in salmon exports since 2013 (£579m), increasing by 20% to £726m in 2017.[19] Whilst imports have also increased over the same period, a 2017 import value of £490m means that the UK had a trade surplus in salmon of £236m in 2017.

3.25 **The UK aquaculture business base is characterised by a small number of finfish producers (mainly salmon, with some trout production) typically located in Scotland, and a larger base of shellfish producers**. Consequently, the vast majority of aquaculture businesses in the UK are micro and small-sized (98%), with only five medium and five large-sized companies operating.[20] This is reflected in 2018 turnover figures for the sector, where 43% turned over less than £100,000 and 83% less than £500,000. All ten high turnover businesses (£10m or more) were based in Scotland. England had the largest number of businesses in 2018 at 235 (54% of all UK aquaculture businesses), with businesses in Scotland accounting for 34% of the UK total – this is somewhat surprising given Scotland's dominance in the sector, however Scotland is highly consolidated. There were 35 and 20 aquaculture businesses in Northern Ireland and Wales, respectively, in 2018. [21]

3.26 **The overall business base in the UK has seen weak growth, with a decrease in the two years to 2018**. Though the UK business increased by 4% between 2014 and 2018 (from 420 businesses to 435), the total number of

[16] https://www.gov.scot/publications/scotlands-marine-economic-statistics/pages/7/

[17] ONS, 2019

[18] ONS, 2018

[19] MMO UK Sea Fisheries (2017)

[20] Micro businesses employ nine people or fewer, small businesses employ up to 49 people; medium-sized enterprises employ 50-249 people; large enterprises employ greater than 250 people.

[21] UK Business Counts (2018)

aquaculture businesses dropped from 450 in 2016 (c.3% decrease). Evidence suggests that the decrease has largely been driven by a decrease in businesses in England.[22]

3.27 **Aquaculture employment in the UK has seen a moderate decrease in the last couple of years**. Total employment dropped by 7% between 2015 and 2017, falling to 3,249 employees. However, there is a varied picture below the UK level. There was a steep drop-off in employment numbers in England across the same time period, falling from 1,375 to 950, a decrease of 31%. Employment in Wales also fell substantially between 2016 and 2017, dropping to 80 from 150.[23] Conversely, employment in Scotland increased by 6% between 2015 and 2017 to 2,125 people, with Scotland consequently accounting for almost two-thirds of total aquaculture employment in the UK. This is followed by England (29%), Northern Ireland (3%) and Wales (2%).[24]

3.28 **GVA for aquaculture has grown strongly between 2013 and 2017**. There has been a 26% increase to £432m of GVA.[25] Regionally, Scotland has consistently accounted for the highest proportion of GVA, accounting for 59% in 2017, whilst also seeing significant growth in absolute terms between 2013 and 2017, rising 61% from £289m to £466m.[26] England accounted for 31% of UK GVA in 2017, having grown by 68% from 2013 to £246m. Northern Ireland accounted for 7% and Wales 3% of GVA, with growth across both since 2013. GVA per worker was highest for England (£89,500) and lowest for Scotland (£77,700) in 2017.[27] GVA per worker in Wales increased substantially from 2013 to 2017, where it more than doubled from £40,000 to £83,600. GVA per worker is proportionally higher across England and Wales in 2017 than in previous years due to reduced employment numbers.

Sector outlook

3.29 Evidence suggests the aquaculture sector in the UK is fairly healthy currently, with growth in both turnover and GVA. Scotland is particularly strong, accounting for the majority of UK turnover and almost two-thirds of all aquaculture employment – both indicators have been on the rise in Scotland over the last five years. Growth is sufficient to contribute to meeting some targets set out in a number of national strategies, but in some instances this will not achieve industry ambitions:

- **Aquaculture Growth to 2030 (Scotland)**: The ambition is to raise aquaculture's economic value to £1.1bn across Scotland by 2030, with an increase in tonnage potentially increasing jobs in the sector to 6,000 (with wider UK economy value of £3.6 billion and 18,000 jobs). This would require

[22] Ibid.

[23] No consistent data for Northern Ireland

[24] BRES (2018) and NISRA (2018)

[25] ONS (2018) Annual Business Survey

[26] Ibid.

[27] Ibid.

a year-on-year growth of 5%. Based on Marine Scotland figures, there has been year-on-year growth in turnover of around 4.8%, which would be sufficient to meet the value target by 2031, one year later; considering the growth over a longer historic period of 8.2% from 2008-16, the target would be met by 2024. However, the employment growth rate is insufficient to meet growth targets for aquaculture in Scotland by 2030. Further, industry ambition is to double output to somewhere in the range of 300,000 to 400,000 tonnes per annum for finfish production, with a median production figure of 350,000 tonnes. Recent research has indicated that dependent factors that would facilitate this 100% increase in production by 2030, along with challenges that would need to be overcome, suggest that a 50% increase in production might be more likely.[28]

- **Seafood 2040 (England)**: There is potential for growth in aquaculture production value from £35m to £60m accounting for seafood consumption levels of two portions per week. To achieve this by 2040, annual growth of under 2.5% is needed. There is no available production value or turnover data for aquaculture only in England, but Aquaculture and Fisheries has an average annual growth rate of +8%, and GVA for aquaculture in England has seen substantial growth as noted above. Assuming this rate of growth for aquaculture only, the target could be achieved by 2023. However, there is a degree of volatility in turnover figures, with negative growth in some years. This may impact on the realisation of targets.
- **Brexit and our Seas (Wales)**: The emerging policy position is prioritising the development of new and existing shellfish activities, supporting new and existing operations to increase finfish production, and promoting diversification of commercially viable species in the marine and inland areas. However, the decrease in aquaculture employment coupled with a stagnation in business growth suggests that this is an ongoing challenge.

3.30 At the UK level, whilst there is a degree of growth – largely in England and Scotland – for Northern Ireland and Wales, growth appears to be a challenge. Further, this growth is not sufficient to be competitive globally: a significant challenge facing the UK aquaculture sector is that of market share. Evidence indicates that in spite of increasing output, the UK's global market share is decreasing. For example, the rate of production growth for salmon in Scotland has been lower than competitor countries, and has resulted in a reduction in global market share from 10% in 2005 to

[28] Imani Development, Westbrook Associates for HIE and Marine Scotland (2017) *The Value of Aquaculture*

To Scotland

between 7% and 8% in 2017.[29,30] This is considered in more detail with regard to Norway's aquaculture sector in the following section.

Aquaculture in Norway

3.31 Aquaculture is an important industry for Norway. Norway accounts for over half the Atlantic salmon produced globally[31], and exports approximately 95% of its total production (1.16m tonnes).[32],[33] Many of Norway's top aquaculture companies such as Marine Harvest (now Mowi) and AKVA Group either operate in the UK, or own UK companies.

3.32 The Norwegian aquaculture sector has realised significant growth in recent years. Its business base has decreased by over 25% in the period 2009-18, but the evidence indicates that there has been consolidation in the industry, similar to the consolidation that has taken place in the Scottish finfish aquaculture sector. Over the same period, employment in Norwegian aquaculture has grown by 68% to over 8,500, and total sales have grown from around £2.29bn (Kr 22.4bn) in 2009 to £6.25bn (Kr 67.8bn) in 2018, an increase of over 272%.[34]

3.33 For comparison with Aquaculture in the UK, over the period 2013-17, employment in Norwegian aquaculture grew by 37%, and sales by 39%. This is significantly stronger performance, which has allowed Norway to grow its global market share to around 54%.[35]

3.34 Whilst the UK's aquaculture sector has grown modestly, its relative growth compared to key competitor markets is considerably weaker. Therefore there is a growth challenge: the UK's ability to grow further is constrained by its lack of competitiveness on a global level.

Seafood processing

3.35 Seafood processing serves both the commercial capture fishing and aquaculture sectors, and so the sector performance is driven largely by performance in those two sectors, as well as by the scale of fish imports. Seafood processing in the UK is largely dominated by operations in England and Scotland. Within Scotland, there are seafood processing clusters in Aberdeen City and Aberdeenshire – particularly at Peterhead – and in the Central Belt. In England, there are strong

[29] Food and Drink Scotland (2017) Aquaculture Growth to 2030: A strategic plan for farming Scotland's seas

[30] EY (2019) The Norwegian Aquaculture Analysis 2018

[31] Ibid., p.22

[32] EY (2018) The Norwegian Aquaculture Analysis 2017

[33] Eurofish International Organisation (2019) at: https://www.eurofish.dk/norway

[34] Directorate of Fisheries, Norway (2019) Statistics for Aquaculture, at: https://www.fiskeridir.no/English/Aquaculture/_Statistics/Total

[35] EY (2019) The Norwegian Aquaculture Analysis 2018

concentrations of activity in Grimsby, North East Lincolnshire – with Grimsby Fish Market, the largest of its kind in the UK – and Heathrow in London.

Figure 2.4: At-a-glance sector assessment for seafood processing

	Business base	Employment	Turnover*	GVA	Trade*	Impact distribution
UK	--	++	+	++	--	-
England	-	++	+	++	N/A	-
Northern Ireland	--	++	--	++	N/A	-
Scotland	--	+	++	++	N/A	-
Wales	+	+	+	++	N/A	--

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

* Wider food manufacturing sector below UK level

Sector performance

3.36 **Turnover in the UK's seafood processing sector has remained broadly constant in recent years**. The turnover of the seafood processing industry in the UK was almost £3bn in 2017. This had fallen slightly from a high of £3.1bn in 2014. The sector is particularly prevalent in Scotland, where it accounted for £1.6bn turnover in 2016, and over one quarter of the wider food manufacturing sector.[36]

3.37 **Salmon exports have increased in value, but there is an overall trade deficit**. Data from Seafish indicates that there was a trade deficit by volume in Seafood of around 250,000 tonnes in the year ending August 2017.[37] In the food products trade deficit is estimated at £4.6bn in 2017, although this includes the processing of meat, fruit and vegetables etc., as well as seafood. In Scotland, latest figures from the Scottish Salmon Producers Organisation show that Scottish salmon exports reached a peak of £600m in 2017[38], making salmon Scotland's number one food export. This high value has been stimulated by an increase in the price of salmon and an increase in export tonnage. It is worth noting that the value of Scottish salmon is also influenced by its marketing and branding as a premium product.

3.38 **The seafood business base in the UK has decreased**. There were just over 300 seafood processing businesses in the UK in 2017, with the majority based in England and Scotland, and very small numbers based in Wales and Northern

[36] Marine Scotland: Scotland's Marine Economic Statistics (2018)

[37] https://www.seafish.org/article/uk-seafood-industry-overview

[38] http://scottishsalmon.co.uk/salmon-exports-reach-record-600m/

Ireland (<10% of overall UK business base). This number has fallen in recent years, with a 10% decrease since 2012; this has been driven by a strong decline in Scotland (-19%).[39]

3.39 **However, employment growth is strong in the seafood sector**. In contrast to the business base, employment in seafood processing has grown in recent years, by 12% from 2012. This suggests consolidation with a smaller number of larger employing companies, or could be evidence of vertical integration with seafood producers acquiring processing operations, since businesses are identified by their main operations. There were over 16,000 people employed in the sector in the UK in 2017, and, again, these are primarily based in England and Scotland. The rise in seafood processing employment has been driven by strong growth in England in particular, whilst job numbers in Northern Ireland, albeit low, have doubled over this period.[40]

3.40 The sector is dominated by non-domiciled workers. A report by Seafish in 2018 estimated that there were 18,000 FTEs working in seafood processing in the UK, and that up to half of these are from the European Economic Area (EEA).[41] This reflects anecdotal evidence from seafood processors that there are challenges in finding locally available labour at current wage levels.

3.41 **GVA growth for the UK's seafood processing industry has grown in recent years**. The UK seafood processing sector accounts for around £580m GVA, which has increased by around 9% over the last five years.[42] Evidence from Seafish indicates that England accounts for over half of the sector's GVA, with Scotland accounting for around a further 45%.[43] GVA per head, or productivity, in the wider food product manufacturing sector is estimated at circa £56,000, and is slightly greater in England than in Scotland.

Sector outlook

3.42 Evidence indicates that the seafood processing sector in the UK is moderately healthy. There has been growth in terms of employment and GVA, and salmon exports in particular have increased in value. However, whilst there has been growth in terms of productivity and efficiency, there has not been growth in absolute terms, with turnover stagnating.

3.43 The outlook of the sector is unclear: there are signs of growth in parts, such as the increase in value and export tonnage of Scottish salmon. Employment and GVA levels have been growing fairly strongly in recent years also. However, the lack of growth in absolute terms, and the trade deficit in seafood are causes for concern.

[39] UK Business Counts, 2018

[40] Business Register and Employment Survey, 2018

[41] https://www.seafish.org/media/2018_seafood_processing_sector_labour_report.pdf

[42] Office of National Statistics, 2018

[43] Seafish, 2018

Also, the vast majority of the impact of seafood processing is based in England and Scotland, with very little activity occurring in Wales and Northern Ireland. This constrains the distribution of impacts across the UK. This leads to a mixed picture in terms of meeting strategic targets:

- **Seafish UK Corporate Plan**: Seafish, the non-departmental public body set up to support the UK seafood industry, has set 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.[44] However, the stagnating turnover of the sector, and the ongoing trade deficit indicate that this is will not be achieved.
- **Seafood 2040 (England)**: A 75% increase in consumption (from 1.15 portions to 2 portions of seafood per person per week) and an additional £4.6bn in sales.[45] Despite the decrease in turnover in recent years, there is evidence to suggest that the value of UK consumption is increasing, though this includes imported seafood products. The value of consumed seafood increased 4.7% to £6.61bn in the UK in year ending June 2017[46]. Even assuming a more modest year-on-year increase of 3%, this target could be reached by 2030.
- **Changing Tides: A strategy for Scotland's seafood industry**: The Scottish food and drink strategy aims to double the value of the sector to £30bn by 2030. The Scottish seafood sector aims to make an important contribution to this, with Changing Tides focusing on four key themes: market development and brand; investment and innovation; people and skills; and supply chain.[47] However, the rate of recent growth in turnover in the Scottish seafood processing sector (based on ONS data) of around 2.2% indicates that doubling the turnover value of seafood processing in Scotland from 2016 would not be achieved by 2030.
- **Wales Seafood Strategy**: Targets 30% sustainable growth of the industry by 2025, with a 10% increase in employment over the same period.[48] At present, the 2% decrease in turnover in the Welsh seafood processing sector (based on ONS data), and static employment levels indicate that this is unlikely to be achieved – though because of the relatively small base in Wales, a small absolute growth in future years could still positively impact on achieving these targets.

[44] https://www.seafish.org/media/Publications/Corporate_Plan_18-21_V2.pdf

[45] https://seafish.org/media/Seafood%202040%20strategic%20framework.pdf

[46] https://www.seafish.org/article/uk-seafood-industry-overview

[47] https://drive.google.com/viewerng/viewer?url=http://seafoodscotland.org/wp-content/uploads/2019/05/Changing-Tides-_FINAL_PAGES.pdf

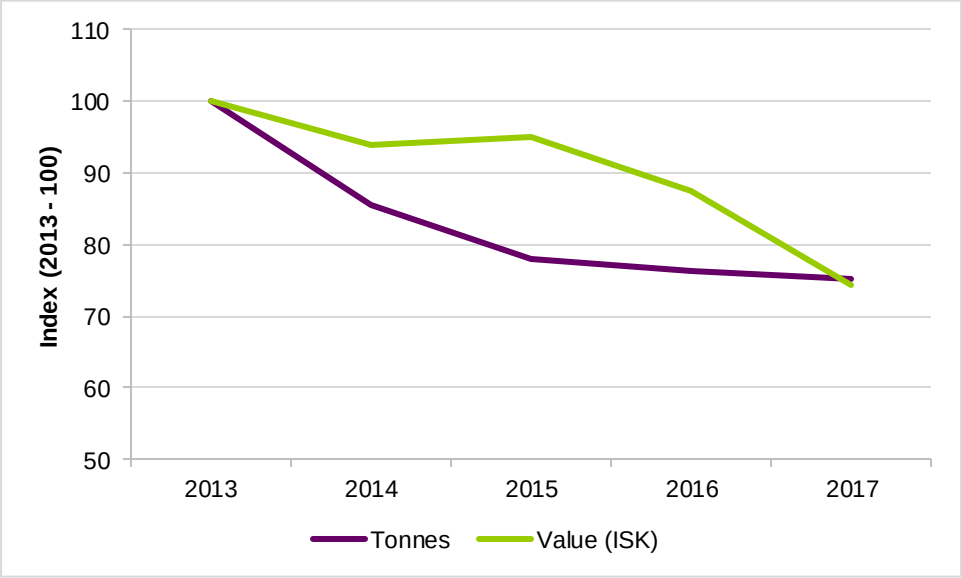
[48] https://www.seafish.org/media/1659099/wales_seafood_strategy.pdf

3.44 The evidence therefore indicates that there is a growth problem for the Seafood industry in the UK. This is not unique to the UK; other countries where there is a large seafood processing industry, such as Iceland, are also facing growth challenges. However, in countries such as Norway, there is considerable growth. The following sections explore this further.

Seafood processing in Iceland and Norway

3.45 Seafood processing, and particularly processing for export, is a major part of Iceland's economy. However, the volume seafood produced for export in recent years has decreased somewhat. Between 2013 and 2017, there was a 25% decrease in tonnage processed for export, from around 786,000 tonnes to just over 590,000 tonnes.[49] Over the same period, the value of processed seafood for export has decreased by a similar proportion, from Kr 265,000bn to Kr 197,000bn.

Figure 2.5: Seafood processing for export in Iceland, indexed, 2013-17



Statistics Iceland, 2019

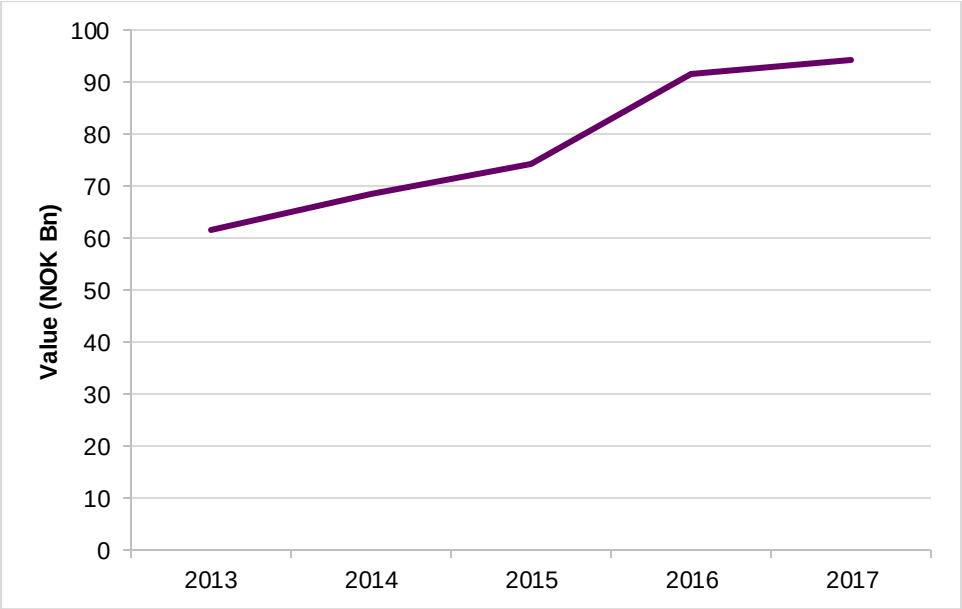
3.46 In contrast, the value of processed seafood exported by Norway has increased year-on-year between 2013 and 2017. Overall, there was a 54% increase in the value of exported seafood to Kr 94.5bn; much of this was salmon (68% of total exports by value), with cod accounting for 10%.[50] The latest data indicate that this has increased further to Kr 99bn in 2018.[51]

[49] Statistics Iceland, 2019

[50] Norwegian Seafood Council, 2018

[51] Norwegian Seafood Council, 2019

Figure 2.6: Seafood processing in Norway, value, 2013-17



Source: Norwegian Seafood Council, 2019

3.47 Consequently the growth challenge in the UK is one of increasing growth overall. This will help to improve the UK's competitiveness versus Norway and other high-growth seafood processing countries. Not addressing this issue will further negatively impact the UK's market share and trade balance. Constraints and challenges to growth are explored further in Chapter 3.

Commercial seaweed harvesting

3.48 Seaweed harvesting has long been a feature of coastal communities in the UK, but this has been, and still is, in the main done by hand for small-scale commercial use or domestic consumption. There are a small number of established areas of commercial production across the UK, but in recent years, there has been growing interest and attention paid to larger-scale commercialisation operations. This acknowledges that seaweed has great potential value, particularly in down-stream uses such as pharmaceuticals and bio-energy applications.

Figure 2.7: At-a-glance sector assessment for commercial seaweed harvesting

	Business base	Employment	Turnover	GVA	Trade	Impact distribution
UK	+	N/A	N/A	N/A	N/A	+
England	N/A	N/A	N/A	N/A	N/A	+
Northern Ireland	N/A	N/A	N/A	N/A	N/A	+
Scotland	N/A	N/A	N/A	N/A	N/A	+
Wales	N/A	N/A	N/A	N/A	N/A	+

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

Sector performance

3.49 Seaweed harvesting is very much a nascent sector in the UK, and therefore estimates around the scale and economic value of the sector are limited at this stage. Viking Fishing Farms in 2012 estimated that the UK microalgae industry had an economic value of between £1m and £1.3m.[52] Despite relative under-development in the UK, harvesting bases have been established in areas of Scotland, Northern Ireland and South Wales, with harvesting historically concentrated in the Scottish Outer Hebrides, estimated to account for 5,500 of 6,000 wet tonnes of total UK harvest.[53]

3.50 More recent estimates of the sector have put total UK harvest at between 20,000 and 30,000 wet tonnes, an increase driven in part by an expansion in harvesting in South West England[54]. Whilst there are development proposals for new kelp harvesting[55], under the current regulatory environment, such projects are unlikely to happen. Research commissioned by HIE has highlighted that despite Scottish seaweed harvesting being of relatively low value in itself, it has the potential to enable very high value manufacturing and pharmaceutical industries (in the range of £100m to £500m after 10 years)[56].

3.51 It was estimated by Viking Fish Farms in 2012 that the UK macroalgae industry constituted 15 SMEs, increasing to 27 following a report conducted by Cefas in 2016. Of the 27 seaweed related businesses identified in the UK in 2016, 16 were

[52] Cefas (2016) Seaweed in the UK and abroad – status, products, limitations, gaps and Cefas role

[53] Ibid.

[54] Ibid.

[55] For example, through their proposals, Marine Biopolymer consider that the sector in Scotland could be worth as much as £300 million: https://www.bbc.co.uk/news/uk-scotland-46252427

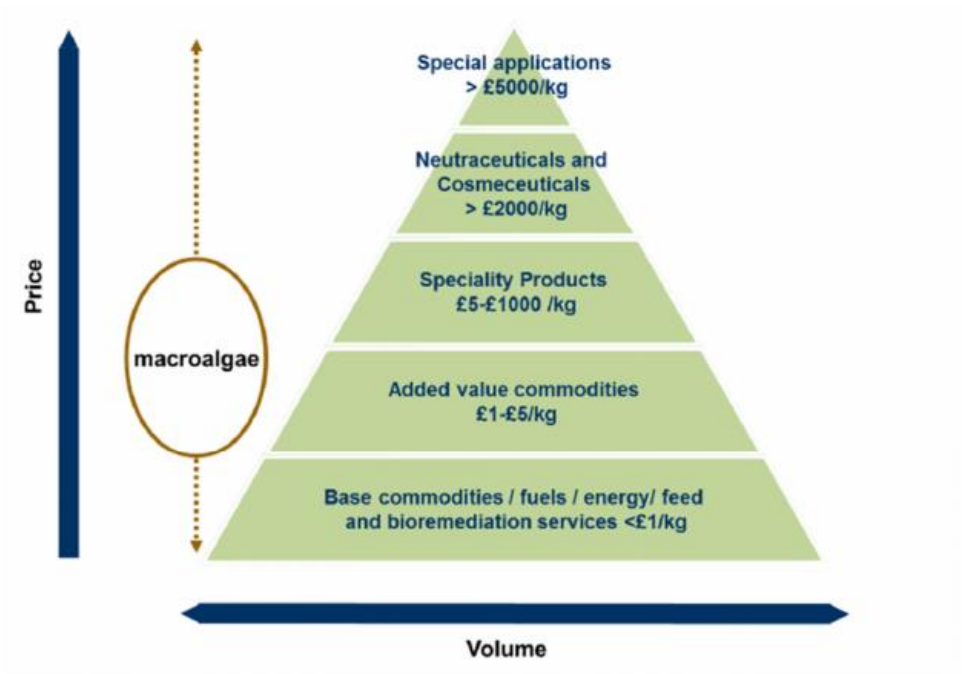
[56] HIE (2018) Wild Seaweed Harvesting as a diversification opportunity for fishermen

using UK harvested seaweed while 11 were using seaweed harvested elsewhere in the world.[57] Eight of the 16 produce seaweeds for food or condiments with the next most common uses being cosmetics and nutraceuticals, followed by animal feed production and fertilisers. There was limited information on staff numbers, however data available indicates most of the 27 businesses were micro (0-9 employees) or small (10-49 employees) in size.

3.52 Regionally, Scotland hosts the majority of UK seaweed businesses (including harvest), with businesses especially concentrated around the islands. There are a further two businesses in Wales, two on the south-west coast of England, one in Essex and one in Northern Ireland. Wild harvest supply issues mean that, as of 2019, those businesses on the south-west coast of England are focused on cultivation.

3.53 The value and productivity associated with seaweed production varies considerably depending on the type of products being produced. For instance, as shown in Figure 2.8, the economic return for biomass is estimated at less than £1 per kg, compared to more than £5,000 per kg for 'special applications'. The UK is currently at the stage of producing added value commodities and speciality products, with values between £1 and £1,000 per kg.

Figure 2.8: Pricing of products from macroalgae and current capacity for macroalgae production in the UK



Source: Cefas, (2016) Seaweed in the UK and abroad – status, products, limitations, gaps and Cefas role

[57] https://www.frontiersin.org/articles/10.3389/fmars.2019.00107/full

3.54 Estimated timescales also vary extensively depending on product type.[58] Some applications, such as cosmetics, fertiliser, sea vegetables and hydrocolloids are already well established with further future growth anticipated. In the longer term, the application of seaweed in industrial biotechnologies, thermal conversion, ethanol and terponoids are still at the research stage, with deployment 10 to 15 years away.

Sector outlook

3.55 Seaweed harvesting is well established in the UK on a small-scale level (for food, feed and fertilisers). However there has been increased awareness of the potential uses of seaweed in recent years, for instance in algal biofuel technologies. This has led to increased interest in seaweed harvesting the UK, albeit based on farming as wild harvesting is close to capacity at locations with existing activity.[59]

3.56 Seaweed farming in the UK is currently at a pre-commercial stage with a number of pilot farms established in Northern Ireland (Queen's University Belfast), Scotland (SAMS) and formerly Wales (Swansea University).[60] These have been developed as a response to wild harvest over-capacity, and if successful could contribute to the UK and regional seaweed sectors. Indeed, current areas of research can also be expected to lead to future seaweed uses with higher value and productivity.

3.57 Whilst there is insufficient evidence to provide a clear indication of whether there is a growth challenge, evidence from elsewhere indicates that other countries, such as the Faroe Islands and Norway are in a more advanced position in terms of development, growth and value of the Seaweed harvesting sector. This is explored in more detail with regard to Norway below.[61]

Norway's seaweed industry

3.58 Seaweed harvesting is an emerging industry in Norway, but is showing signs of relatively rapid growth. In contrast to the UK, seaweed harvesting in Norway is largely of farmed algae, i.e. seaweed *cultivation*. The Norwegian Directorate of Fisheries identifies seaweed harvesting as an important, new priority in aquaculture (Seaweed harvesting is considered a subsector of aquaculture in Norway). Kelp species produced and harvested include sea belt (*Saccharina latissima*), babberlocks (*Alaria esculenta*), dulse and nori nei. The first licences for seaweed harvesting were awarded in 2014. The Norwegian seaweed harvesting sector has undergone significant growth in recent years. Its business base has grown from 10 companies in

[58] Adapt/Innovate UK, NERC (2013)

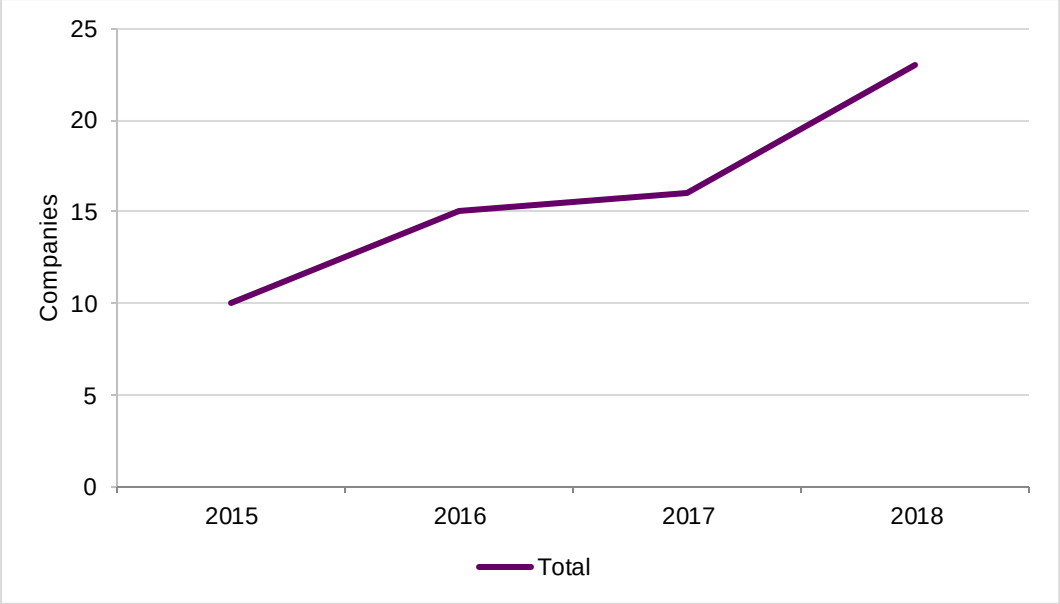
[59] Cefas (2016) Seaweed in the UK and abroad – status, products, limitations, gaps and Cefas role

[60] https://www.frontiersin.org/articles/10.3389/fmars.2019.00107/full

[61] Though companies such as TARI and Ocean Rainforest are expanding their seaweed cultivation and harvesting operations, there is limited statistical information about the Faroese seaweed sector as a whole.

2015 to 23 in 2018 (Figure 2.9), an increase of 130% over the period, albeit within the context of small business numbers.

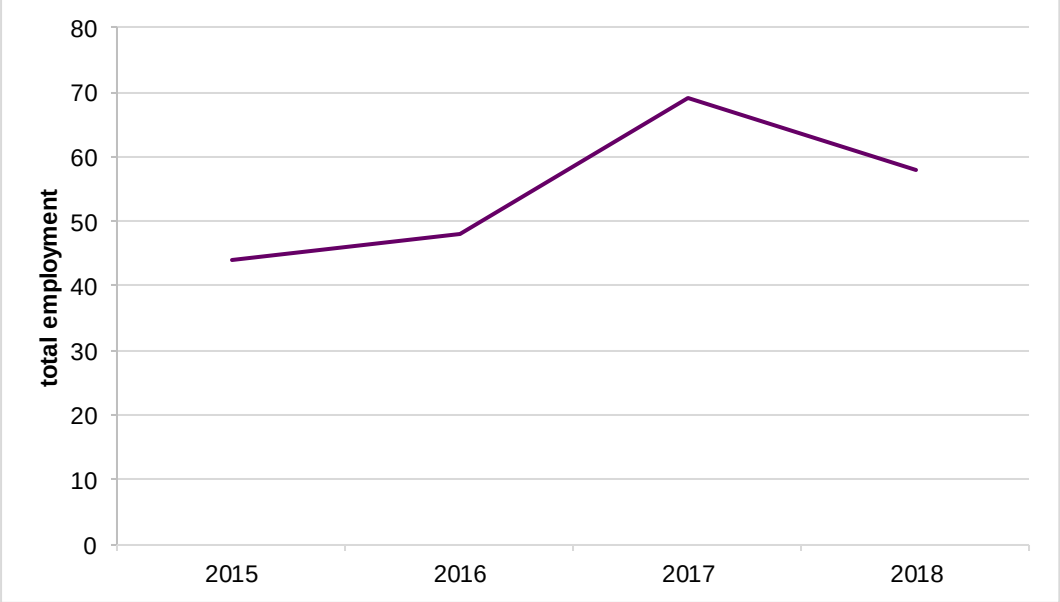
Figure 2.9: Norwegian seaweed harvesting business base, 2015-2018



Directorate of Fisheries, Norway, 2019

3.59 Employment in Norwegian seaweed harvesting has grown overall over the same period, by 32%, as shown in Figure 2.10. However, following a peak of 69 total employees in 2017, seaweed harvesting employment fell to 58 in 2018, a decrease of 19%.

Figure 2.10: Norwegian seaweed harvesting employment, 2015-2018

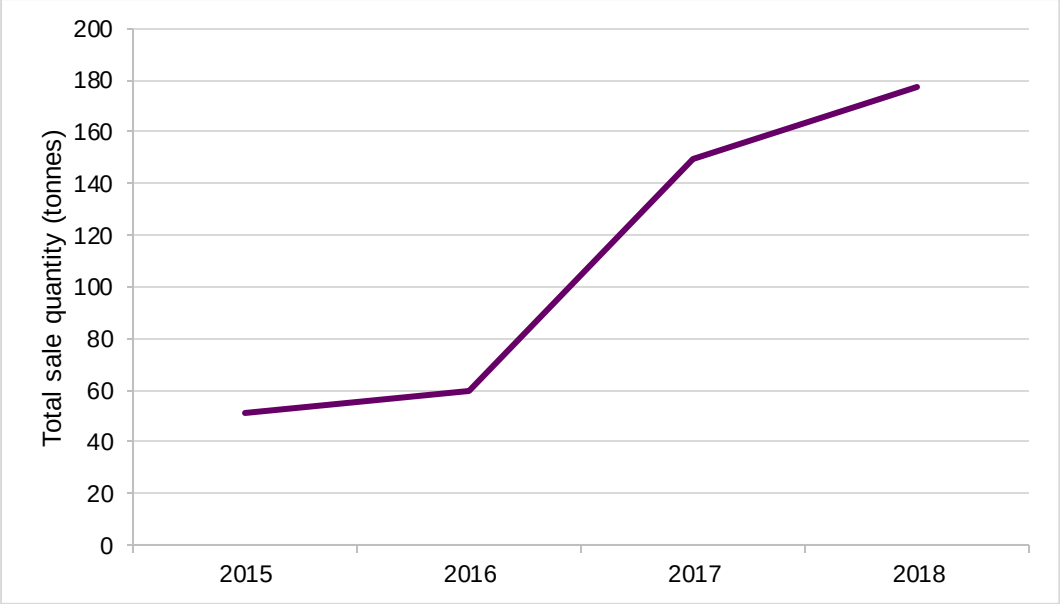


Directorate of Fisheries, Norway, 2019

3.60 Overall tonnage and value of seaweed harvested has increased over the period 2015 to 2018, as shown in Figures 2.11 and 2.12. Harvesting tonnage increased by 248%, rising from 51 tonnes to 178 tonnes. This has been largely a

result of an increase in Sea Belt algae, with tonnage growing from 33 tonnes in 2016 to 140 tonnes in 2017.

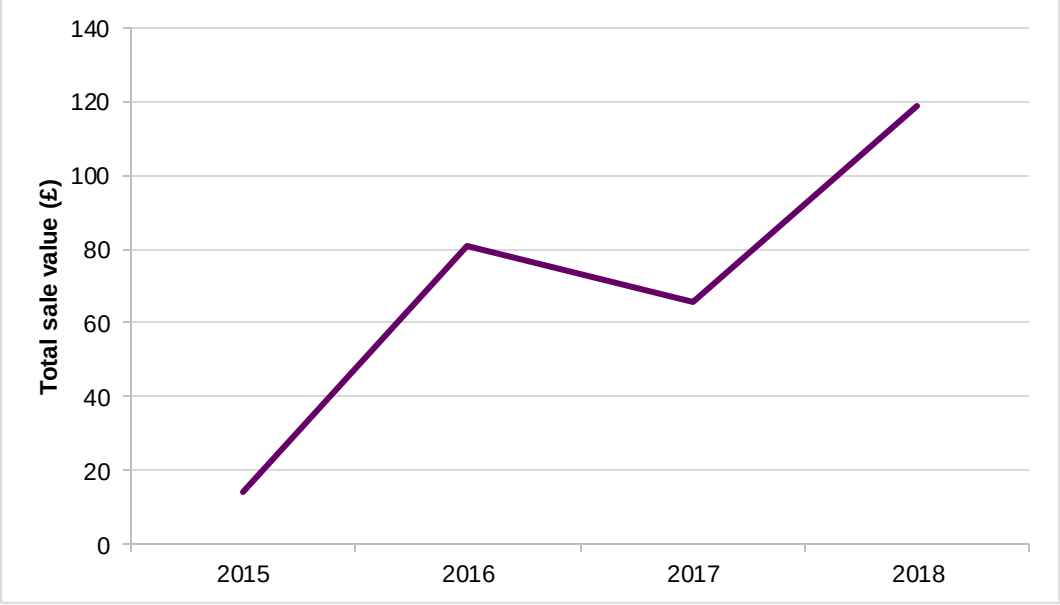
Figure 2.11: Norwegian seaweed harvesting quantity (tonnes), 2015-2018



Directorate of Fisheries, Norway, 2019

3.61 The value of seaweed harvested grew at a significantly higher rate between 2015 and 2018, increasing 722% from around £14,000 to almost £119,000.

Figure 2.12: Norwegian seaweed harvesting value (1000 £), 2015-2018



Directorate of Fisheries, Norway, 2019

3.62 Whilst evidence indicates that the UK's production of harvested seaweed is greater than that of Norway, the growth challenge facing the UK's seaweed industry is one of competitiveness. The lack of consistent and robust data on the UK's seaweed harvesting sector is an added factor in determining its competitiveness.

Offshore renewables

3.63 The UK offshore renewables sector is a dynamic and rapidly expanding field and is expected to play a significant role in providing energy for the UK and globally. Renewable energy presents the best opportunity for cheaper, cleaner and faster decarbonisation. 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. It is anticipated that offshore wind alone will provide a third of the UK's electricity by 2030.[62]

Figure 2.13: At-a-glance sector assessment for offshore renewables

	Business base*	Employment *	Turnover	GVA	Trade	Impact distribution
UK	++	++	++	++	-	+
England	++	+	++	N/A	--	+
Northern Ireland	+	+	++	N/A	+	+
Scotland	+	++	++	N/A	++	+
Wales	+	-	-	N/A	--	+

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

* For offshore wind only

Sector performance

3.64 In 2015 it was estimated that the UK offshore renewables sector has a total (including indirect and induced) turnover impact of £4.7bn.[63] Whilst the UK leads the world in wave and tidal development, the technologies in these two are less developed than offshore wind in terms of maturity and they are currently more expensive. The offshore wind sector is estimated to have directly turned over more than £3.5bn in 2017[64], representing 29% of the total £12.3bn directly generated by the UK's low carbon electricity sector. As Table 2.1 illustrates, the majority of turnover within the UK offshore wind sector was generated in England (91%), with the other significant share of turnover, albeit it much less, accrued in Scotland (9%).

[62] Offshore Renewable Energy Catapult, 2019

[63] The economic contribution of the UK marine industry - Cebr (September 2017)

[64] ONS analysis from the Low Carbon and Renewable Energy Economy Survey provides a 2017 turnover estimate for the offshore wind sector but not the wave and tidal sectors, due to their relatively small contributions to the low carbon energy sector as a whole.

Table 2.1: Turnover, £000s – Offshore wind by country

Date	UK	England	Scotland	Wales	Northern Ireland
2014	2,938,000	2,496,000	95,000	341,500	6,000
2015	2,388,000	2,208,000	n/a	117,000	n/a
2016	2,628,500	2,224,500	300,500	67,000	36,000
2017	3,573,000	3,235,000	304,000	26,000	8,000

Source: ONS, Low carbon and renewable energy economy, UK: 2017

3.65 Marine renewable energy had an estimated direct GVA impact in the UK of £730m in 2015.[65] In addition to these direct impacts the sector was estimated to have annual indirect GVA benefits of £511m stimulated in supply chains and induce a further £256m in the wider economy when direct and indirect employees spend their earnings.

3.66 The regional distribution of the wave and tidal energy sectors' is different to offshore wind, with wave and tidal clusters and key assets in Cornwall, the Solent, Wales and the Highlands and Islands.[66] In Scotland, the European Marine Energy Centre (EMEC) in Orkney has generated £194m of GVA for the UK economy and created 3,801 job years on the islands. The Beatrice Offshore Windfarm Ltd, which opened in July 2019, is Scotland's largest offshore wind farm, and is expected to create around 90 full-time jobs over the course of its 25 year lifespan, while powering 450,000 homes with an installed capacity of 588MW and 84 turbines. In the South West, cutting edge facilities have generated over £170m of investment in the last decade and created more than 400 marine energy jobs in the region.[67]

3.67 In 2017, the UK offshore wind sector accounted for 7,200 jobs (of the estimated 32,200 full-time equivalent (FTE) jobs in the wider sector), and these were concentrated in NW England, SE England, Yorkshire and Humber. Recent estimates put the employment supported by wave and tidal energy at 1,700.[68]

3.68 The past decade has seen a significant step-change in the scale of marine renewable infrastructure. As Figure 2.14 indicates, 2017 was the first year that the offshore renewables sector generated over 6% of UK electricity.

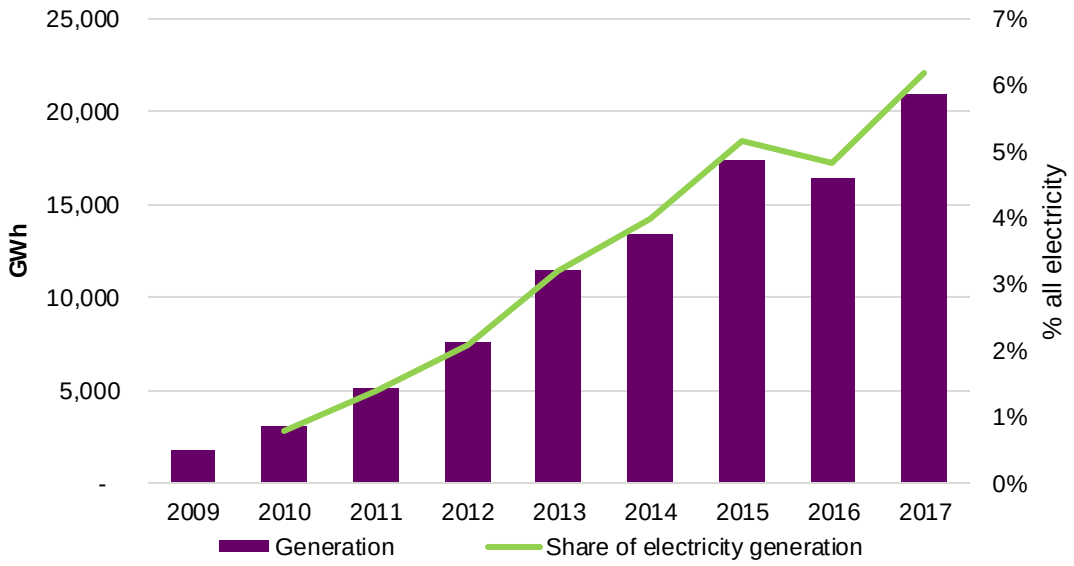
[65] Cebr (2017) The economic contribution of the UK marine industry

[66] Renewables UK (Feb 2017), Ocean Energy Race: The UK's Inside Track

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

[68] Ibid.

Figure 2.14: Electricity generated by offshore renewables



Source: BEIS, Renewable electricity capacity and generation

3.69 The offshore wind sector constitutes roughly 10% (2,500) of the approximately 23,000 UK low carbon electricity production businesses. The majority of these businesses are operating in England (2,000) and Scotland is the only other nation with a significant number of active companies (500).

Sector outlook

3.70 The UK's natural assets and success to date in deployment and generation, particularly in offshore wind but more recently in tidal energy, mean offshore renewables are set to grow strongly and the economic opportunity in offshore renewables energy is robust and growing. Analysis suggests that the regions of the UK which currently have the highest direct employment from the offshore wind sub-sector are the North West and South East of England with between 2,000 and 4,000 direct FTE jobs. However forecast projections suggest that by 2032, employment will be highest in the North East, and Yorkshire and Humber (>4,000 FTEs).[69]

3.71 The North East's offshore wind sector has been named as one of four regions set to become part of a new £250m Offshore Wind Growth Partnership (OWGP). The Partnership is expected to drive investment in areas such as advanced manufacturing, floating wind and larger turbines as well as create new, high-skilled jobs in the region.[70] The world's biggest offshore windfarm, Hornsea, is located off the Yorkshire coast and is forecast to be fully operational by 2020 with additional Hornsea projects either in the construction or development phases.[71] However, whilst these developments are positive, meeting the 2050 UK emissions target may

[69] Source: Cambridge Econometrics (June 2017) Future UK Employment in the Offshore Wind Industry

[70] https://www.chroniclelive.co.uk/business/business-news/north-east-play-leading-role-15939570

[71] https://orsted.co.uk/en/Generating-energy/Offshore-wind/Our-wind-farms

require a large-scale rollout of low-carbon generation over the next decade, with strain put on existing renewable technologies.

3.72 Challenges to future development include marine technologies competing with alternative technology options that are more cost-effective, such as wind. There are also challenges around integrating low-carbon technologies into the existing UK generation system (given decentralisation and intermittency of generation), and commitment from UK government to provide ongoing, sustained support for the development of the marine energy sector for the foreseeable future.

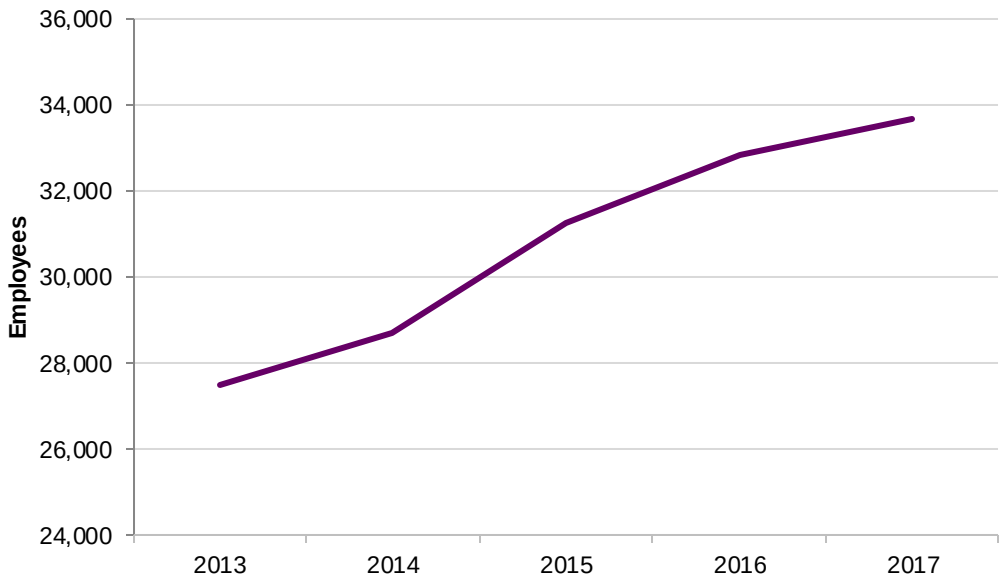
Competitor comparison: offshore renewables in Denmark

3.73 Denmark is a global leader in offshore renewables energy and an interesting comparator for the UK. In Denmark there are more than 500 companies, working in all areas of the wind industry.[72] Two Danish manufacturers, Siemens Wind Power and MHI Vestas Offshore Wind, dominate the global market for offshore wind turbines and together, they have produced almost 90% of all the offshore wind turbines installed in Denmark. Siemens is also involved in the Beatrice Offshore Wind Development, through Siemens Gamesa.

3.74 Figure 2.15 shows the total number of people employed by Wind Denmark between 2013 and 2017 in Denmark. The number of employees in offshore and onshore wind has risen steadily over the five year period, increasing from around 27,490 in 2013 to over 33,660 in 2017 – an overall increase in employment of 22%. The UK offshore wind sector accounted for 7,200 jobs in the UK in 2017, with the wider offshore renewables sector accounting for around 32,200, putting Denmark slightly ahead of the UK in terms of overall employment in wind energy.

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

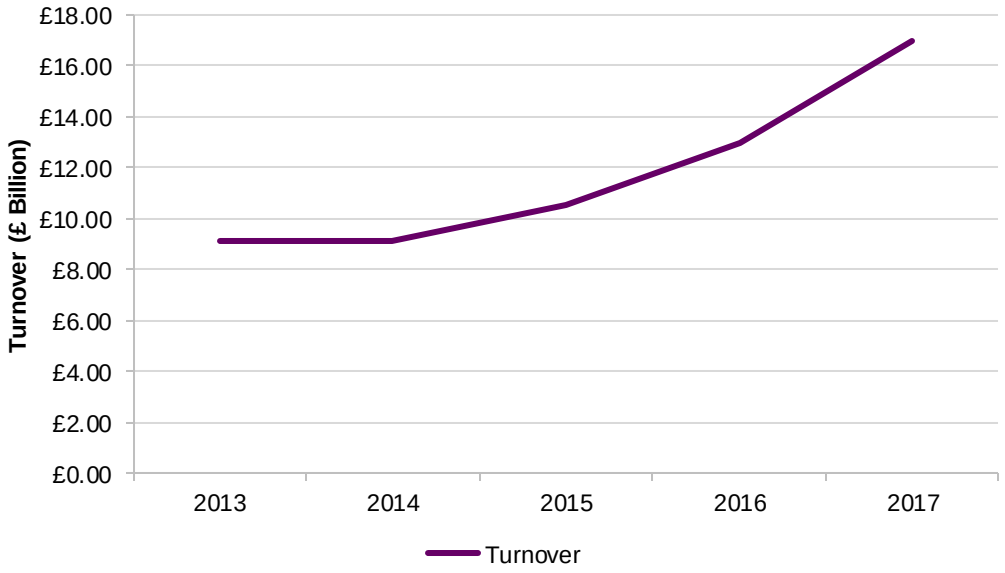
Figure 2.15: Number of people employed by Wind Denmark, offshore and onshore, 2013-2017



Source: Industry Statistics, Wind Denmark 2014-2018

3.75 Total revenue of the offshore and onshore wind turbine industry in Denmark was £16.94bn in 2017, increasing from £12.96bn the year prior (an increase of 31%). Over the five year period between 2013 and 2017, revenue in offshore and onshore wind turbines rose significantly by 85%, up from £9.15bn. The UK offshore wind sector generated an estimated £3.5bn in turnover in 2017. The reasons for the difference in turnover between the UK and Danish sectors is unclear, though it may be related to the maturity of the Danish wind energy sector.

Figure 2.16: Total revenue in Denmark's offshore and onshore wind turbine industry, 2013-2017



Source: Industry Statistics, Wind Denmark 2014-2018

3.76 The number of wind turbines (on and off-shore) in 2017 was 6,161, an increase in volume of over 20% since 2010. Around 8% of these were offshore turbines (519). Capacity of wind turbines has also increased, from around 3,700 MW in the early 2010s to 5,522 MW in 2017.[73] Capacity of offshore wind in 2017 was 1,297 MW, around 23% of the overall wind turbine capacity in Denmark.

3.77 Table 2.2 shows the number of offshore wind turbines connected in Denmark between 2013 and 2018, as well as the total wind power generated the number of offshore wind farms developed across the same period. The total number of connected offshore wind turbines in Denmark was 514 in 2018, eight more than the previous year and over 400 more than in 2013. This marks an overall increase in connected turbines of 430%.

3.78 Total power in Megawatts increased from 350 MW to 1,329 MW over the same period, rising 280%. The number of offshore wind farms also increased from one in 2013 to 14 in 2018.

Table 2.2: Number of offshore wind turbines connected, Denmark, 2013-2018[74]

	2013	2014	2015	2016	2017	2018
Farms	1	12	13	13	16	14
Turbines connected	97	513	513	517	506	514
MW connected to grid	350	1,271	1,271	1,271	1,266	1,329

Source: WindEurope, 2013-2018

3.79 Figure 2.3 shows the total primary renewable energy production in Denmark first, from 1990 to 2010 over ten and five year periods, and then from 2015 to 2018 annually. Primary renewable energy production was 45.46 Petajoules[75] in 1990, increasing to 131.31 PJ in 2010, a rise of around 189%. Despite a minor decline between 2015 and 2016, production increased to 174.64 PJ in 2018, and overall increase of 281%.

3.80 Offshore renewables in the UK generated 23,000 Gigawatt hours[76] of electricity in 2017, the equivalent of 82.8 PJ. This was around half the total primary renewable energy production in Denmark in 2017.

[73] https://ens.dk/sites/ens.dk/files/Statistik/energyindenmark2017.pdf

[74] https://windeurope.org/about-wind/statistics/offshore/

[75] Petajoule = 10^{15} joules

[76] Gigawatt hour = 1bn watt hours

Table 2.3: Primary[77] renewable[78] energy production in Denmark, 1990-2018

Year (1990-2010)	1990	2000	2005	2010
Renewable Energy (PJ)	45.46	76.02	105.58	131.31
Years (2015-2018)	**2015**	**2016**	**2017**	**2018***
Renewable Energy (PJ)	159.16	158.59	170.57	174.64

Source: Danish Energy Agency, 2018

3.81 Observed renewable energy consumption in Denmark is shown in Table 2.4, covering the same 1990 to 2018 time period. Consumption has increased at a greater rate than production since 1990, rising by 269% between 1990 and 2010, and 439% across the 18 year period to 2018.

Table 2.4: Observed renewable energy consumption in Denmark, 1990-2018

Year (1990-2010)	1990	2000	2005	2010
Renewable Energy (PJ)	45.46	78.51	121.88	167.94
Years (2015-2018)	**2015**	**2016**	**2017**	**2018***
Renewable Energy (PJ)	210.04	217.51	244.16	244.82

Source: Danish Energy Agency, 2018

Oil and Gas decommissioning

3.82 Decommissioning is part of the natural lifecycle of oil and gas assets. It is the obligation of all oil and gas operators to decommission offshore assets once they have ceased production. The oil and gas sector has experienced significant challenges in recent years since the downturn of oil prices from late 2014, as shown in the sector overview table above, however decommissioning is one area which is performing well and has a strong outlook with significant opportunities in the UK.

3.83 Given that many assets in the UK Continental Shelf (UKCS) are beginning to come to the end of their lifecycle, UK expenditure on oil and gas decommissioning is rising and was estimated to be £1.8bn in 2017. This is an increase of more than 60% from 2014 expenditure levels.[79] This strong growth is also set during the period when the overall expenditure on the UKCS fell by almost 50%, reflecting a challenging period of market conditions. However, decommissioning still accounts for a very small proportion of overall industry expenditure on oil and gas in the UKCS, at 8% in 2017. This is due to the drop in oil prices since 2014 meaning that industry is looking to increase efficiencies and reduce decommissioning expenditure.

[77] Primary renewable energy is energy that is harvested directly from natural resources, including energy from wind, tides, coal and oil.

[78] Renewable energy in this instance accounts for wind, wood, waste/renewable, straw, biogas, and heat pumps

[79] Oil and Gas UK Business Outlook, 2018 – see https://cld.bz/c41vNPt/6/

Figure 2.17: At-a-glance sector assessment for oil & gas decommissioning

	Business base+	Employment+	Turnover*	GVA	Trade#	Impact distribution
UK	--	-	++	--	--	-
England	--	--	N/A	N/A	N/A	+
Northern Ireland	-	N/A	N/A	N/A	N/A	--
Scotland	--	-	N/A	N/A	N/A	+
Wales	-	--	N/A	N/A	N/A	--

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

+ For Support activities for petroleum and natural gas extraction
* Based on decommissioning expenditure as part of wider oil & gas activity
# For wider 'Mining support service activities sector'

Sector performance

3.84 **Overall oil and gas support activity turnover has decreased in the last few years**. In the UK, the total turnover of businesses providing support activities for oil and gas extraction (of which decommissioning is part) was almost £5.4bn in 2017, although this had fallen significantly from a peak of £7.9bn in 2014 before the oil prices decline.

3.85 **The business and employment base for oil and gas support activity has also decreased, though largely as a result of the oil & gas industry downturn**. There were 210 businesses in the UK involved in support activities for oil and gas extraction in 2018, and they were broadly split between England and Scotland.[80] This total number of businesses has fallen substantially since 2013, particularly so in Scotland (-85; -45%). The sector employed c.20,000 people in 2017, with the vast majority of these being based in Scotland and particularly in Aberdeen City and Aberdeenshire. Again, over the period of falling oil prices (i.e. since 2014), employment numbers have been declining in Scotland (-18%) and England (-63%). Very little oil and gas decommissioning economic activity is based in Northern Ireland and Wales.

3.86 **GVA for the oil & gas decommissioning sector has increased recently, in contrast to the business base and employment**. GVA for the wider oil and gas extraction sector has fluctuated widely over the last decade, from a high of £3.18bn in 2008 to a low of £1.46bn in 2016. Most recent figures place it at £2.38bn for 2017. GVA per worker in the sector, an indicator of productivity, is very high at £121,000, over double the UK average. This reflects the high value nature of the sector. GVA

[80] UK Business Counts, 2018

per worker has grown since 2014 suggesting forced increasing efficiencies by oil and gas companies as a result of the oil price crash.

Sector outlook

3.87 It is forecast that £15.2bn will be spent on oil and gas decommissioning projects in the UKCS over the next decade, from 2019 to 2028.[81] Geographically, almost half of this expenditure is forecast for the Central North Sea, and, by activity, almost half of expenditure is expected to be on well plugging and abandonment activities. Cumulative expenditure over the next decade has been revised downward somewhat, 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 & gas decommissioning activity, and therefore expenditure.

3.88 Wood Mackenzie forecasts that, over the period, the UK will have the highest decommissioning spend in the world, accounting for 33% of the forecast expenditure by the top 12 global markets.[82] Forecast spends by the USA and Norway is second and third. Regulations in other countries differ to that of the UK. For example, the disposal of platforms at sea and being converted into artificial reefs is allowed in the USA.

3.89 After a sustained period of rising oil prices followed by a rapid fall from 2014, the sector is now committed to operational improvements and cutting expenditure. This will be key to the UK positioning itself as a global leader in decommissioning.

3.90 There is also 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.[83] 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.

3.91 When decommissioning, operators are required to assess the environmental and societal impacts of different activities, in particular the impact on commercial fisheries which can lead to negative consequences such as damaged equipment and spoilt catches.[84] The number of incidents reported has fallen significantly over time,

[81] Oil & Gas UK, Decommissioning Insight, 2019

[82] Wood Mackenzie, US$32bn of decommissioning worldwide over the next five years: is the industry ready?,2017

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

[84] Rouse, S., Hayes, P and Wilding, T.A. (2018) "Commercial fisheries loses arising from interactions with offshore pipelines and other oil and gas infrastructure and activities", *ICES Journal of Marine Science*

and this is likely due to improved technology and communication. Going forward, oil and gas operators will need to continue to take cognisance of the impact of their decommissioning activities on other marine sectors and the marine environment.

Oil and gas decommissioning in Norway

3.92 On the Norwegian shelf, there are currently 12 concrete facilities, 23 steel floating facilities and 59 steel facilities resting on the seabed. In addition, there are nearly 400 subsea installations. The concrete facilities account for around 70% of the total weight of facilities on the shelf. Thus far, the Frigg field is the largest field on the shelf where facility decommissioning has been completed following production ceasing in 2004. Offshore disposal work began in 2005 and the extensive work was completed in 2010.[85]

3.93 At present, authorities in Norway have processed around 20 decommissioning plans, making disposal decisions where a final deadline has been set for the completion of removal projects. Between 2016 and 2021, up to 25% of the fields currently on stream will be able to be closed. It is difficult to predict when producing fields will be shut down, as shown in Table 2.5 below.

Table 2.5: Change in estimate lifetime for selected Norwegian oil and gas fields, 1980-2050

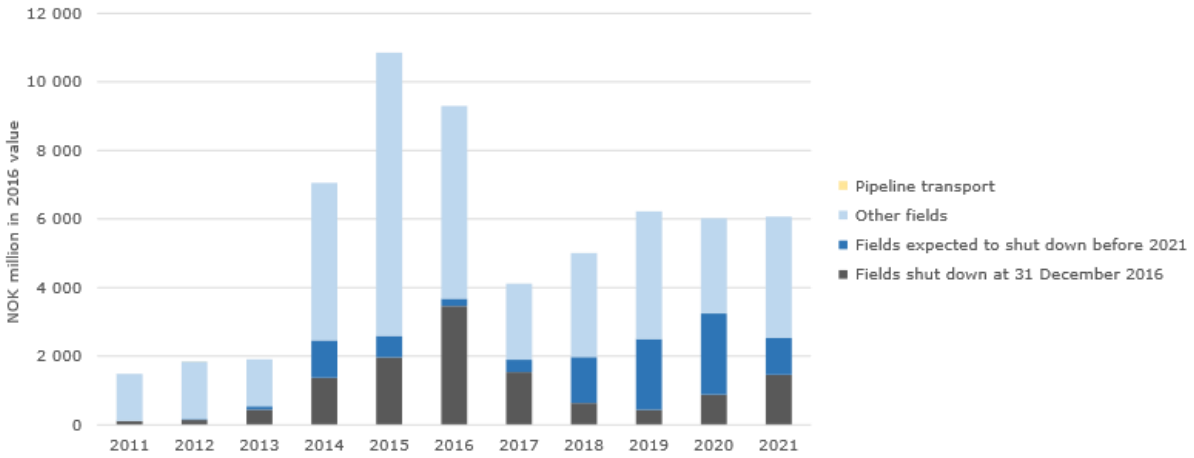
	Latest year of reported production in:		
Field	**1992-1995**	**2002**	**2018**
Veslefrikk	2007	2014	2025
Varg	2003	2006	2016
Statfjord	2007	2020	2025
Gullfaks	2004	2016	2042
Ekofisk	2025	2028	2050
Draugen	2007	2016	2035
Brage	2005	2008	2030

Source: Norwegian Petroleum Directorate, 2018

3.94 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.

[85] https://www.norskpetroleum.no/en/developments-and-operations/cessation-and-decommissioning/

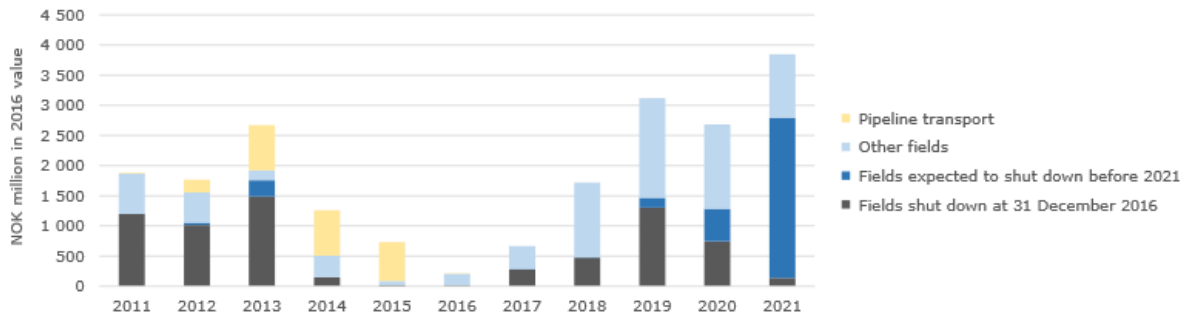
Figure 2.18: Field shut-down costs, 2011-2021[86]



Source: Norwegian Petroleum Directorate, 2016

3.95 Shut-down and disposal costs decreased from £3.3bn in 2010 to £858m in 2015.[87] It was forecast that the decommissioning costs in 2016 would total approximately £2.1bn, and by 2021 this figure would be £1.1bn[88], based on predicted lifespan for existing oilfields on the Norwegian shelf. From 2011 to 2021, decommissioning costs will account for 3% of the £263bn used or intended to be spent on petroleum activities, broken down into: 58% investment, 24% operating costs, 12% exploration costs, 3% cessation costs, and 3% other costs. This is a considerably lower proportion than for the UK oil & gas decommissioning sector.

Figure 2.19: Field disposal costs, 2011-2021



Source: Norwegian Petroleum Directorate, 2016

3.96 Longer term estimates put Norwegian decommission expenditure among the third highest globally after the UK and the United States. From 2018 to 2027, Wood Mackenzie forecasts Norwegian expenditure to be around £9bn, one-third of the UK total expenditure (£27bn).[89] During this time, Norway expects to decommission 363 wells (subsea and platform), initially at a pace of 22 per year until 2024 and thereafter

[86] https://www.npd.no/en/facts/publications/reports2/resource-report/resource-report-2017/cessation/decommissioning-costs/

[87] Using an average exchange rate from between 2010 and 2015

[88] Using an average exchange rate from between 2016 and 2018

[89] Decommissioning Insight Report, Oil and Gas UK (2018) https://oilandgasuk.co.uk/wp-content/uploads/2019/03/OGUK-Decommissioning-Insight-Report-2018.pdf

at an average of 70 per year from 2025 to 2027 following the beginning phases of some large decommissioning projects.

3.97 Another competitor/comparator sectors is the Netherlands, who anticipate decommissioning 419 wells (suspended subsea exploration and appraisal, subsea development and platform) between 2018 and 2027. It is expected the majority of these wells will be fully decommissioned by the end of 2025.

3.98 Based on the available evidence, and taking the global downturn in the oil & gas industry into consideration, it can be argued that there is no growth challenge in the industry, but rather that any changes in the sector are subject to global trends and influences. The UK is positioned well globally in terms of the scale of its activity, and this is forecast to continue growing over the next decade. There nevertheless are industry-specific constraints that impact on the productivity and efficiency of the sector, and these are explored in more detail in Chapter 3.

Marine tourism

3.99 Marine tourism forms a major 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 level. At a global level, there are varying definitions of marine tourism, which results in a lack of comparable data – where this is available.

3.100 As Figure 2.20 illustrates, marine tourism in the UK has grown in recent years, but the extent to which this growth has been seen across the UK is not clear. The following sections examine this in more detail.

Figure 2.20: At-a-glance sector assessment for marine tourism

	Business base	Employment	Turnover	GVA	Trade	Impact distribution
UK	N/A	+	++	++	++	+
England	N/A	+	N/A	N/A	N/A	+
Northern Ireland	N/A	+	N/A	N/A	N/A	+
Scotland	N/A	++	++	++	++	+
Wales	N/A	+	N/A	N/A	N/A	+

Key	++	Strong growth; widespread distribution of impacts	+	Weak or no growth; weak distribution of impacts	-	Weak negative growth; poor distribution of impacts	--	Substantial negative growth; very poor impact distribution	N/A	No data available

Sector overview

3.101 The marine tourism sector in the UK was valued at an estimated £4-5bn in 2016.[90] As Table 2.6 indicates, marine tourism in Scotland had a turnover of £1.0bn in 2016 (increasing by over a third from £746m in 2009), leading to a GVA contribution to the economy of £554m, whilst the total spend generated by domestic coastal tourism in England and Wales is approximately £8bn, and the sector contributes £3.6bn in GVA a year. UK marine leisure exports were estimated to be £882m in 2015.

Table 2.6: Summary of GVA and Turnover Estimates

Geography	Turnover	GVA	Sector
England and Wales	£8.0bn	£3.6bn	Domestic Coastal Tourism
Scotland	£1.0bn	£554m	Marine Tourism
Northern Ireland	£926m	-	Total Tourism
UK[1]	-	£4-5bn	Marine Tourism

Source: National Coastal Tourism Academy; Scottish Government; North Ireland Statistics and Research Agency; Big Lottery Fund

Sector performance

3.102 Coastal tourism in England and Wales directly supported 212,000 jobs in 2010-2012 (up from 207,000 in 2006-08), and that the number indirectly supported could be as high as 600,000.[91] There is a more recent figure for marine tourism employment in Scotland, in 2016 an estimated 27,900 jobs were in the sector, up 15% from 2008.[92] In Northern Ireland, the visitor economy as a whole supported

[90] Big Lottery Fund (Nov 2016), Coastal Communities Fund Annual Progress Report 2016

[91] Beatty, Fothergill and Gore (July 2014), The Seaside Tourist Industry in England and Wales Employment, economic output, location and trends

[92] Scottish Government (Oct 2018), Scotland's Marine Economic Statistics

more than 61,000 jobs in 2017,[93] and coastal tourism represents a significant proportion of the wider tourism turnover in the region (£926m in 2017, up from £641m in 2011[94]).

3.103 Tourism is a key employer in many coastal areas in the UK, with boating related tourism alone having created 62,200 new jobs (between 2013 and 2018). Indeed, direct boating tourism contributes more GVA to the UK economy than other sectors individually including the agriculture, forestry and fishing industry, and motion picture and television programme production. Table 2.7 illustrates that at a local level in England and Wales, coastal tourism has the largest employment impact in the South West, where nearly a third of the England and Wales total are employed. The South West and South East are the locations for growth in employment with the employment numbers and in the North West and Wales falling since 2006/08.

Table 2.7: Average year-round employment directly supported by seaside tourism

Region	2006/08	2010/12
South West	61,000	68,000
South East	46,000	49,000
North West	29,000	25,000
East of England	23,000	23,000
Wales	20,000	19,000
Yorkshire and Humber	14,000	14,000
North East	7,000	7,000
East Midlands	6,000	7,000
England and Wales	207,000	212,000

Source: Beatty, Fothergill and Gore (2014)

3.104 However, like the wider tourism sector, marine tourism faces challenges in attracting talent; this is a significant challenge for the tourism sector not just across the UK, but more widely.[95] This is related to real and/or perceived low pay, high turnover of staff, competition from other sectors, long shifts and the seasonality of work.

3.105 Within the boating tourism sub-sector, boat hire, charter and training contributed the most GVA (£132m) to the UK economy. This can be attributed to increased spending on leisure activities as wealth and disposable incomes rose following the UK's recovery from the financial crisis.

Sector outlook

3.106 The marine tourism sector demonstrates the potential for further industry growth, and there are several examples of strong performance within sub-sectors of marine tourism. Sailing tourism in Scotland is projected to increase to potentially

[93] http://www.irishnews.com/business/2018/06/08/news/record-year-for-tourism-in-northern-ireland-as-trips-bed-nights-and-spend-all-increase-1350501/

[94] Northern Ireland Statistics and Research Agency, Annual Tourism Statistics Publications

[95] For example, see: UKCES (2012) Sector Skills Insights: Tourism; Marine Tourism Development Group (2017) Marine Tourism Skills Pathway Plan: Discussion Paper

£167m by 2020 (from an estimated economic value of around £130m in 2015), exceeding its initial £145m target.[96] The growth in economic value of marine tourism is also projected to rise from £360m in 2015 to around £450m in 2020 supported by Scotland's National Marine Tourism Strategy 'Awakening the Giant,' which is set to provide authentic experiences through new cruise routes and themed journeys among others.[97] Further, there is a growth globally in more sustainable forms of tourism generally, and this can support social and environmental benefits in local areas. For example, well-managed wildlife-based tourism can offer an economic opportunity that supports wildlife, as well as a range of well-being benefits.[98] However, it must be responsibly managed and operators must engage with staff, customers and, most importantly, local people.

Broader sector trends

3.107 Coastal and maritime tourism has become a major economic sector for countries with accessible and attractive coastlines, and is considered to be one of the fastest growing forms of tourism. In global terms, the marine tourism market was worth US$ 59 billion in 2018, and is anticipated to grow 7% to US$ 93 billion by 2025.[99] Cruise tourism is a major component of this. In 2010, 19 million passengers across the world booked cruise trips and by 2017 the number had risen to 26.7m, exceeding all projections.[100] Europe accounted for 26% of this total, equating to almost 7 million passengers.

3.108 Sailing and yachting is also anticipated to grow. There is a huge potential for boating growth in Europe – it is home to an estimated 36 million boaters, a fleet of around 6 million boats, and some of the world's most popular sailing grounds served by more than 4,500 marinas.[101] However, participation in sailing has been trending downwards since 2002.[102] In contrast, marine leisure activities such as paddle-boarding, kayaking and surfing are growing.

3.109 Wildlife-based tourism is growing rapidly worldwide as the number of tourists continues to grow and as travellers seek out new and more enriching personal experiences with local cultures and wildlife. It is estimated that 7% of the world's tourism in 2017 related to wildlife tourism, growing annually at about 3%, and much higher in some places (like UNESCO world heritage sites).[103] Around 4% of holiday trips in the UK include some element of wildlife. Wildlife operators see the majority of their visitors as combining a strong interest in wildlife watching (such as whale and

[96] https://www.sailscotland.co.uk/news/posts/2017/sailing-tourism-to-grow-by-37m/

[97] http://www.hie.co.uk/growth-sectors/tourism/marine-tourism-strategy/deafult.html

[98] https://doi.org/10.1080/13683500903042857

[99] QYResearch Group (2019) Global Marine Tourism Market Size, Status and Forecast 2019-2025

[100] https://www.celestyalcruises.uk/en-uk/cruise-lines-international-association-updates-official-2017-global-passenger-numbers

[101] https://www.ibinews.com/market-intelligence/market-overview-europe/33030.article

[102] https://www.yachtingmonthly.com/news/future-uk-sailing-68018

[103] UN World Tourism Organisation, 2017

dolphin watching, along with other species including seals and birds) with other activities, such as walking, cycling, touring, sightseeing, photography, history, culture and visiting distilleries, which may make up the primary purpose of their visit.[104]

[104] https://www2.gov.scot/Resource/Doc/311951/0098489.pdf

4 Constraints and challenges for marine sectors

Introduction

4.1 This chapter sets out the main constraints and challenges facing the marine sectors across the UK. It draws on the findings of the literature review, and in-depth fieldwork with stakeholders and key informants from the consultation and workshops. It focuses on the issues identified by stakeholders as being of primary consideration, and is not intended as a comprehensive analysis of all challenges and constraints facing the sector. Rather, it provides a summary of challenges and constraints, with emphasis on the issues identified by stakeholders and policymakers as being of primary consideration.

4.2 The analysis considers a series of overarching and cross-cutting challenges and constraints for the marine sector as a whole, before examining sector-specific challenges. It makes a distinction between long-term structural challenges, and more transitory issues, such as political uncertainty.

Overarching challenges and cross-cutting constraints

Main challenges and constraints

Spatial variations in sectoral significance

4.3 The research highlighted a number of transitory issues concerning integration of marine sectors. Through this work – and also in previous studies undertaken by ekosgen, Imani Development and others – integration between marine sectors and indeed other land-based sectors where appropriate is a long-term opportunity to realise sustainable growth. For example, a number of industry players and strategic actors are currently considering the scope for co-location and clustering of marine economy activity across sectors, such as integrated marine energy and aquaculture operations. The MAXiMAR Marine Economy Science and Innovation Audit[105] identified an opportunity to develop a cluster model across aquaculture, marine biotechnology and marine renewables (wave and tidal) in Scotland. Previous research for the SIA had identified conflict between the differing user groups, and findings from consultations for this research confirmed this competition for marine space and resource. Such a model would address a co-ordination failure across three key marine sectors for the UK. This would create the conditions to maximise innovation and support sector growth. A key feature would be joint working, collaboration and knowledge exchange, leading to the exploration of co-location and joint venture opportunities. However there are often conflicts between different

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

marine users in the same seaspace, with few resolutions. An example is the conflict between fisheries and offshore wind in terms of using the same marine space.[106]

4.4 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.

4.5 Conversely, stakeholders raised concern that the weighting of marine sector interests in devolved administrations are not fully understood at UK level. There is a worry therefore that conflating sectors in future interventions and support mechanisms would not recognise the specific challenges and requirements of individual sectors, thus disadvantaging them. Recent trends in Government and Enterprise Agency support at the UK and devolved national administration level has seen a shift in emphasis from a sectoral policy focus to one of opportunities. There is a danger that quite distinct issues for each sector – and especially for commercial capture fishing and aquaculture, where they are significant and separate industries for Scotland, but proportionally far less so in England – become blurred and are not dealt with in the most effective or appropriate manner. For example, there is genuine concern amongst stakeholders in Scotland that aquaculture is subsumed in wider debates and discussions regarding fisheries – there is a perception that the proportional scale and significance of Scottish aquaculture is not recognised at the UK level, in part because it is a comparatively smaller sector outside of Scotland.

4.6 It may also be an issue *within* sectors. In marine renewable energy, evidence suggests that emerging energy sources such as wave and tidal are at a disadvantage in relation to offshore wind. Support mechanisms such as Contracts for Difference (CfD) arguably favour off-shore wind and make no specific provision for wave and tidal energy.

4.7 There was broad agreement across stakeholders that a one-size support will not fit all. There should be parity across each of the UK's constituent countries and sectors in future support priority decisions. The sectors in each country should have equitable access to support and that it should take account of the mix of uses and users. This would avoid a conflation of sectors and devolved administrative geographies.

Impact of geography

4.8 The geography of the UK and the impact that it has on the marine economy presents some significant structural challenges. The regions and locations where marine sector activity is concentrated are often remote and rural, with poor transport links and limited access to skills. For example, many of the UK's fishing ports such

[106] https://www.politico.eu/article/fishermen-offshore-wind-farms-struggle-to-share-sea/

as Lerwick, Brixham, Portavogie and Fishguard are in largely rural areas, and some distance from major urban areas. This geography and topography can place constraints on supporting infrastructure, and increase time and distance to market as well as to supply chain and ancillary service providers.

4.9 For example, many commercial capture fishing operations are located in peripheral regions, particularly inshore fisheries. Consequently, they can be a considerable distance from processing facilities and the market. Similarly, many marine tourism destinations are in rural and often remote areas, there is a twin challenge of attracting visitors to the destination, and also providing the necessary infrastructure to ensure a positive visitor experience and ensuring no negative impact on the communities.

Data and intelligence

4.10 Fully understanding the marine environment and the impacts of different activities is crucial for managing it sustainably and ensuring that we maximise the economic and social potential. This requires robust, credible and up-to-date evidence but there is a perception that data and data collection is currently limited and not fit for purpose which is a clear market failure impacting on sustainable growth. Some current 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.

4.11 Firstly, this lack of data may be regarding relative economic performance of sectors – such as international trade, where specific sector data is often subsumed in to or combined with other sectors (e.g. fisheries and aquaculture), or only partly available (e.g. Scottish salmon exports versus exports for UK aquaculture as a whole). Secondly, there may also be a challenge where robust data on environmental and natural resource factors is lacking, e.g. marine quality, stock levels, impacts/rate of climate change, or impact of marine activity on marine life.[107] Without this data it is not possible to effectively plan and manage sustainable growth across marine sectors and so it is a market failure.

4.12 It results in a lack of understanding and clarity about the marine environment, and relative performance of sectors. This could result in unnecessary environmental damage and/or, lack of growth in the sector because the risk of environmental impact and mitigating actions are not fully understood. Consultees agreed that a lack of understanding can also lead to tension between marine user groups, such as tourism and leisure activity or that of aquaculture, for example. Both may potentially impact the quality and therefore the productivity and growth potential of the other, but the extent to which this happens is often not clear. It can result in user groups and stakeholders lobbying and potentially influencing policy with limited or imperfect

[107] For example, see: https://www.hw.ac.uk/news/articles/2019/mussels-stressed-out-by-underwater-noise.htm

information. Ultimately, this leads to policy and legislative decision-making that is only partly informed.

4.13 There has, as a result been changes in the monitoring landscape: commercial capture fishing, for example, has an interest in demonstrating that it has a track record of fishing a particular marine area without negative consequences. In aquaculture, publishing of monitoring data is seen as vital in maintaining transparency and growth of the sector. Across all sectors, good quality data and intelligence will mean that there can be sector growth that is adequately balanced with environmental impact and that risk of negative environmental impacts can be managed and mitigated.

Structural workforce, employment and community challenges

4.14 Marine sectors are often key sources of employment in remote and coastal communities. Whilst there are, for example, a number of fishing communities throughout the UK where the share of employment from the sector is very low, such as Dartmouth or Scarborough, there are many other communities, particularly in the Highlands and Islands of Scotland, that are largely dependent on marine sector economic activity due to their fragile socio-economic nature. Sectors such as aquaculture or marine renewable energy can provide employment, including high value jobs in rural areas. For example, the Scottish Salmon Company is a major employer in parts of Argyll & Bute, Highland and the Western Isles, in remote locations such as Cairndow, Raasay and Plocrapol. They can also be high-volume employers, either in relative or absolute terms. In many coastal communities, tourism (and therefore marine-related tourism) is a significant employer. Though the overall effect of marine sector operations on communities depends on a number of complex and inter-related factors, they can often have a disproportionately large impact on the communities and locations in which they are rooted even where absolute employment is low, underlining the importance of supporting their long-term viability and sustainability as part of the inclusive growth agenda.

4.15 A key challenge faced by marine economy employers is recruiting and retaining the skills they need, e.g. engineering or higher-level scientific skills, particularly when they compete with other sectors. As identified by consultees through this research, and also in related research[108], jobs in the marine economy, such as fishing, aquaculture and seafood processing are considered to be less attractive than those in other sectors, which can make it difficult to encourage people to take up employment in them. There is broad agreement amongst stakeholders that people prefer to work in other sectors such as (land-based) tourism, hospitality or the public sector rather than in most sectors of the marine economy. They may also choose sectors where the terms and conditions seem particularly attractive such

[108] e.g. ekosgen, Imani Development for HIE (2018) Skills Review for the Aquaculture sector; ekosgen, Imani Development for HIE (2018) MAXiMAR: Maximising the Marine Economy in the Highlands and Islands; Marine Scotland Science (2014) An Assessment of the Conditions Affecting Entry into the Scottish Fishing Industry and Potential Policy Responses

as oil & gas, which presents a particular challenge for other sectors in North East Scotland.

4.16 The issue of attracting and retaining a skilled workforce is a market failure that could impact on sector growth if employers are not able to sustain an adequate workforce to maintain and expand operations in the UK. This is a challenge identified through the research with stakeholders, and supported by findings from other research.[109] However the solutions are complex and span a range inter-connecting issues and policy areas. Illustrating this, as well as competing with other sectors for staff, marine sector employers can find it difficult to attract people to work in remote areas where infrastructure and access to services and amenities is limited. A key issue is a lack of affordable housing.[110] This has led some aquaculture employers to develop their own housing, in partnership with communities, e.g. in Ullapool[111], and on the Isle of Rum.[112] Other solutions such as shift working patterns akin to those employed in the oil & gas sector, e.g. two weeks on, two weeks off, are also being used by some aquaculture employers, though this has implications for community integration and sustainability.

4.17 In a number of sectors, the reliance on a non-domestic workforce means that there can be a disconnect between sectors and the communities that support them. Across fisheries, aquaculture and seafood processing, EU and non-EU nationals comprise significant proportions of the UK's workforce. For example, over 27% of Scotland's fishing workforce is non UK, with over 19% being non-EEA workers.[113] However, the proportion of Northern Ireland's fleet workforce that is non-UK is much higher: approximately 40% of jobs on Northern Ireland-registered vessels were filled by non-UK citizens.[114]

4.18 In Seafood processing, over 40% of employees are non-UK, with the majority coming from the EU. This is most acute in North East Scotland, where 70% are from the EU.[115] It is clear that immigration policy will have an impact, and if a sizeable proportion of the workforce are not from the UK, then the benefits to the economy and to local communities may be diminished. This is a significant structural challenge.

4.19 Subsequently, this creates further challenges for employers gaining access to sector entrants in an environment where the local labour supply may not exist.

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[109] Ibid.

[110] e.g. Ipsos MORI and Indigo Housing for HIE (2017) *Stimulating Housing Development in the Highlands and Islands*, at: http://www.hie.co.uk/regional-information/economic-reports-and-research/archive/stimulating-housing-development-in-the-highlands-and-islands.html

[111] https://www.heraldscotland.com/news/17845218.new-homes-ensure-salmon-farms-catch-keep-staff/

[112] https://www.pressandjournal.co.uk/fp/news/highlands/1676921/steps-under-way-to-boost-rums-population-after-application-lodged-for-homes/

[113] https://www.gov.scot/publications/scottish-sea-fisheries-employment-2015/pages/4/

[114] Seafish (2019) 2018 Employment in the UK Fishing Fleet

[115] Seafish (2017) Seafish Economic Analysis: UK seafood processing sector labour 2017

Though this is an issue that has arisen as a result of Brexit in the immediate term, it is arguable that the challenge of ensuring labour supply – domestic or otherwise – for the longer-term sustainability of businesses is a critical one.

Environment and natural resources

4.20 There are two aspects to environmental constraints and failures in the marine economy, which can be conceptualised as a circular loop. The first is how the changing marine environment and quality impacts on the sectors, and the second is how the sectors impact on the marine environment. The marine environment sets the initial parameters; industry and other groups (along with other forms of human activity) have an impact on the environment, whether directly or indirectly, which ultimately alters the parameters of the natural environment. This is a critical and long-term issue. If economic operators in the marine environment do not address the evident negative externalities, then negative climate change impacts will be perpetuated, and future marine economic activity will be limited.

4.21 In terms of the changes in the marine environment the most critical structural challenge is climate change. Climate change is causing water temperatures to rise along with changing currents and maritime meteorological conditions.[116] These changes in aquatic conditions will potentially have profound impacts. The risk of disease and pathogens may increase as a result of a rise in water temperature and other factors. There will be a shift in species distribution meaning that the UK may lose some species, or they will shift north, and new species will move in to our waters. The extent of this is a huge unknown but there is no doubt that there will be a significant knock-on effect for commercial capture fishing and aquaculture, and what species may be caught or farmed and so may for example, be a threat to Scotland's salmon farming industry and shellfish farming in Northern Ireland.

4.22 A change in marine conditions may also lead to changes in the best locations for some of marine activities and the supply chain. For example, the location of aquaculture sites; the ability for capture fisheries to fish in different areas and sea conditions, and the vessels and equipment required to do so; the price and acceptability of transporting fresh produce by air transport.

4.23 The impact of climate change on the UK marine environment is a clear and significant market failure. If the sectors affected, and indeed the wider UK and global economy, do not respond positively, then this would have serious implications for the sustainability of the marine economy and the sectors that comprise it, for example fisheries and aquaculture.

4.24 As well as affecting the productivity and quality of the marine environment as a natural resource, falling water quality will impact on the attractiveness of the marine environment. This is a particular challenge in Northern Ireland where it was reported

[116] 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

by stakeholders that the degradation in water quality now means that some of the locally produced shellfish must be treated before going to market. This negative externality from others sectors and activities is a serious market failure impacting on the marine economy. Further degradation would result in produce being categorised as not fit for human consumption and so there would not be a viable product for the market. This is also an issue in England, where stakeholders reported that water discharges from sewage and floodwater is polluting areas that could potentially be used for aquaculture production.

4.25 Although there are undoubted challenges, climate change may offer some new opportunities, such as the potential to cultivate new species – though this would be dependent on market demand, particularly in domestic markets. It may also enable different marine leisure activities, whereby UK residents shift to domestic leisure consumption – this could revitalise some coastal communities if flying for traditional beach holidays becomes constrained. However the number of overseas tourists to the UK may fall for the same reason. Additionally, the scope for marine leisure activities may be negatively impacted due to predicted climate change impacts on the UK, e.g. warmer temperatures, but wetter and more extreme weather events.[117]

4.26 As well as being impacted *by* changes in the marine environment, marine economy sectors also impact *on* the environment. As discussed in the previous section (paragraphs 3.10-3.13), there is a lack of comprehensive, good quality data that gives a full and up to date picture of the nature and extent of these impacts. The challenge here is how to understand and monitor and respond to them appropriately, mitigating risk but at the same time, ensuring that the sectors have the opportunity to grow sustainably.

4.27 Marine litter is increasingly recognised as an issue in the UK and worldwide. In Northern Ireland, litter in ports and harbours – including dumping of old vessels rather than decommissioning – is causing environmental damage and blight. Stakeholders in Wales noted that because of the nature of tidal and sea currents and wider meteorological conditions, the country's coastline has a significant sea litter problem, in common with much of the UK's west coast. This is a major challenge for all marine industries – whether due to the impact on marine wildlife, or on the appearance of the marine environments; one consultee noted that:

> "…tourists want coastal areas and waters to look pristine".

4.28 The current high quality of coastal waters means that UK seafood produce can sometimes command a premium price, but this competitive advantage is at risk if the challenges and market failures are not addressed and water quality deteriorates.

[117] Committee on Climate Change (2020) How a changing climate affects us, at: https://www.theccc.org.uk/tackling-climate-change/the-science-of-climate-change/how-a-changing-climate-affects-us/; Met Office (2019) UK Climate Projections 2018, at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

Infrastructure across the marine economy

4.29 A challenge identified by stakeholders is that many harbours, ports and marinas, and other coastal infrastructure are in disrepair and require modernisation and refurbishment. This is a market failure in terms of ensuring adequate port infrastructure to support the sustainable growth of marine sectors that rely on UK 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 not 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.[118]

4.30 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 for example new fisheries facilities in Peterhead and Brixham. There is evidence to suggest that investment has in part been influenced by (or has at least followed) the uptake and geographical distribution of fishing quotas, with some stakeholders arguing that other, smaller ports miss out on investment as a result. Wales is a prime example as the majority of its catch tends to be of non-quota species.

4.31 Similarly, cruise tourism hubs such as Portsmouth[119] and Southampton[120] have attracted significant investment from cruise companies in recent years but investment has been more limited outside of these areas. Elsewhere, investment plans to attract a larger market share of cruise tourism are often driven by larger ports themselves, e.g. at Invergordon.[121] There are similar plans for key ports in Northern Ireland, targeting commercial capture fishing, but these are still under discussion.

4.32 These factors have led to there being a historic lack of investment and innovation in smaller ports, so negatively impacting on marine sectors and employers that would or do use them. These businesses may have to use alternative ports, incur additional costs or be less productive and profitable. It is however widely acknowledged that 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

[118] https://www.hie.co.uk/latest-news/2019/february/14/funding-boost-for-stornoway-port-developments/

[119] https://worldmaritimenews.com/archives/192487/royal-caribbean-chooses-southampton-as-its-uk-home/

[120] https://www.cruiseandferry.net/articles/brittany-ferries-extends-partnership-with-portsmouth

[121] https://www.ross-shirejournal.co.uk/news/invergordon-25m-investment-plan-amidst-cruise-business-shake-up-147845/

singular functions or sectors. Equally, there may be reasons to have spatial distribution of different activities across port infrastructure: coordination of interests and business cases can be difficult.

> "The challenge is that different ports are different sizes, and have to contend with different types of geographies and ownership – so it's hard to generalise about their challenges, they are all unique models."

4.33 There are some examples of good integration that helps to improve port infrastructure. Pittenweem and Kirkcudbright in Scotland, or Whitby and Southwold in England, for example, balance fishing interests with helping to support vibrant tourism sectors. The mix of users and uses needs to be carefully considered and managed for example, ensuring tourists can safely access what are often working ports with associated risks (cranes, equipment, heavy loads, trucks requiring access), and that commercial users such as fishing boats are not restricted or inconvenienced. The positive impacts often outweigh the challenges – upgraded safety features, improved access to port-side space as well as to the water, and ports and harbours that are opened up to tourists seeking 'authentic' areas and locally caught products, thereby increasing local spend and better distribution of impacts.

4.34 Small ports will often lack the necessary on-site and supporting infrastructure for easy access to market which constrains the growth of marine industries such as fishing. This is a challenge for the large number of smaller ports across the UK, and is highlighted as a particular challenge in Wales, Northern Ireland, the west coast of Scotland and some parts of England, e.g. East Anglia. Northern Ireland has an added complication in that it has a geologically 'soft' coastline[122] meaning that hard infrastructure at one point in the coastline can accelerate erosion at another point. This is a negative externality which may justify additional research to fully understand potential impacts, or investment support to avoid knock-on effects.

4.35 However, a strong environmental lobby in some parts of the UK (e.g. Northern Ireland); and political sensitivity around the location of operations such as processing can be a barrier to port renewal and diversification. Concerns around displacement as a result of regenerating port infrastructure compounds this.

4.36 Nevertheless, there are some good examples of activities to revive smaller ports. For example, the Renaissance of the East Anglia Fisheries (REAF) project aims to revitalise East Anglia's fishing industry. The partnership of local authorities and industry is currently developing a long-term strategy to enable the local fishing industry and coastal communities to optimise the economic benefit of the area's fisheries.[123] Many stakeholders believe that there is a public good argument, as well as public safety considerations for driving investment in smaller ports. For example

[122] http://www.niassembly.gov.uk/globalassets/documents/raise/knowledge_exchange/briefing_papers/series4/2015-04-15-kess-shoreline-management-planning-in-northern-ireland1.pdf

[123] https://www.eastsuffolk.gov.uk/news/help-develop-east-anglias-fishing-strategy/

through regional growth funds, as in Poole through the Dorset Growth Deal[124], Workington through the Cumbria Growth Deal[125], and Ardrossan as part of the Ayrshire Growth Deal[126], a number of ports and marinas are undergoing redevelopment and regeneration. These investments are addressing market failure through positive externalities – the wider benefits to communities and local economies around small ports have not always factored in the decision-making of investors and port operators regarding investment and facilities upgrading.

Financial challenges across the marine economy

4.37 Across marine sectors and uses, access to finance was reported as a key challenge that can constrain growth of businesses and sectors. Many stakeholders reported that businesses can find it difficult to secure investment for example to buy and upgrade equipment, and invest in new technologies and staff development and training. The outcome is that they are not as efficient and productive as they could be and so risk losing competitive advantage. If there is a critical mass of underinvestment in a sector, then there is likely to be a loss of market share and a loss of global competitiveness.

4.38 A key issue is that the return on investment in marine sectors is often realised in the longer term and is perceived as riskier than banks allow for. There is also a lack of understanding of marine sectors on the part of lenders, for example how assets are viewed and how that relates to risk assessment (an information failure).

4.39 Methods of financing depend on industry structure, and in turn shape its development. In inshore fishing, succession in the sub-sector will depend on whether the upcoming generations of would-be owner-operators can finance their boats. There are a small number of examples of good practice in local funding models for fishermen to secure investment. For example, the Western Isles have developed a Fisheries Investment Scheme funded by the council (Comhairle nan Eilean Siar) and supported by the Western Isles Fishermen's Association, which works with a bank partner (in this case Royal Bank of Scotland) to provide loans to finance fishing boats. Other fishermen's associations can provide co-operative financing to younger fishers but there is consensus amongst stakeholders that structured support as in the Western Isles is desirable to ensure succession of competitive inshore fishing fleets. However, if there is no viable way to do this on a larger scale, then there is a clear market failure in providing the necessary investment to help grow the sector.

4.40 The increased drive for traceability and security of supply means that processors have an interest in financing and owning boats in the fishing fleet. This vertically integrated model may increasingly reflect the type of structure seen in salmon farming. In shellfish, a co-operative model has emerged for processing and

[124] https://www.poole.gov.uk/streets-and-travel/transport-policy/dorset-growth-deal/

[125] https://www.cumbria.gov.uk/business/ecodev/growthdeal.asp

[126] https://www.deliveringforscotland.gov.uk/ayrshire-growth-deal/

marketing, but differences in scale of member companies may mask the degree of constraint of financing on the smaller operators. In offshore renewables, the financing model is radically different with large funders and dedicated public-financed innovation funds seeking to capture a share of (or all of) the global market.

4.41 The issue of investment and access to finance is discussed in more detail in subsequent sections that focus on specific sub-sectors.

Political constraints

4.42 It is arguable that the key political constraints on the marine economy are a result of issues around Brexit, and therefore transitory rather than being a market failure. It potentially presents challenges around the workforce and exporting processes, with serious implications.

4.43 As discussed, for many marine economy-related sectors, there is a high proportion of non-UK workers, many from the EU. Uncertainty around Brexit has already meant that the flow of EU workers in to the UK has slowed and some are leaving, impacting marine sectors as well as other parts of the UK economy. This is a transitory challenge as well as a more structural one. Withdrawal from the EU without a deal, or in a 'Hard' Brexit scenario would have negative implications for EU nationals working in the UK's marine sectors, with EU nationals potentially becoming unable to work and live in the UK due to barriers surrounding work visas and residency.

4.44 Access to markets is another important challenge facing marine sectors, with issues around export markets, tariff and non-tariff barriers. Whilst this is not a market failure, these barriers can have a negative impact on the time taken to get produce to markets which is critical in the case of perishable and time-sensitive seafood, since the value of these products is time limited.[127] These barriers are dealt with in specific relation to fishing, aquaculture and seafood processing in subsequent sections.

Co-ordination failures and shared access to resources

4.45 Stakeholders from all four UK countries and across all user groups pointed to the increasing competition for marine space as a constraint for sustainable growth of the marine economy. Achieving an optimal balance of uses is challenging, since competing uses in the same seaspace often lead to friction. This can be complicated by the impact of different uses not being fully understood through a lack of research and data, as noted above (paragraphs 3.10-3.13). Decisions are therefore being taken by policymakers, strategic planners, etc. in the absence of reliable and comprehensive intelligence.

4.46 There is a balance that must be struck across social, environmental and economic demands to ensure a sustainable, thriving marine economy in the UK.

[127] For example, Scottish salmon currently takes as little as three days from farm to end consumer in international export markets: https://www.scotsman.com/business/how-scottish-salmon-exports-its-way-around-the-world-and-maintains-its-reputation-1-4950692

Safeguarding the marine environment was generally considered paramount but as discussed, gaining a clear and balanced understanding was considered crucial. It is also recognised that the marine environment can provide economic and social benefits and it is important that all decisions makers and stakeholders have clear information to inform policy and strategy. Another consideration is how different users impact on each other for example, enhancing or diminishing the marine tourism visitor experience, impacts of one type of activity (renewable energy) on access to prime fishing sites and so forth.

Commercial capture fishing

Sector overview

4.47 As demonstrated in Chapter 2, a key feature of the Commercial Capture Fishing sector in the UK is the diversity of the industry across the four countries in terms of the nature of the fleet and the species. The industry in each has specific needs, and country-specific support and solutions are required to support the development of Commercial Capture Fishing across the UK. Addressing the productivity challenge will help to enhance the Commercial capture fishing sector's growth, and secure greater market share, and therefore must be a focus for the industry in future.

4.48 There has been some modernisation and consolidation in the Commercial Capture Fishing industry in recent years, particularly in demersal and white fish catching. The majority of the UK's catch is offshore[128], and the majority of offshore fishing boat ownership is concentrated in a relatively small number of companies, compared to inshore fishing.

4.49 Stakeholders believe that the consolidation of the fleet means that smaller scale benefits, which would otherwise be significant for smaller coastal communities, are lost because economic impacts are concentrated in a smaller number of locations and in a smaller number of businesses. Given the importance of fishing in many rural and remote coastal communities, 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. This is something that is starting to come to the fore in industry and public debate as processes around Brexit continue, where uncertainty and (at the very least) changing markets means that those with least resilience to change may be less able to adapt.

4.50 Vertical integration with processors or co-operative organisations is one option to manage change, and new markets, for example in Asia, may be accessible if the potentially high costs and risks of transition can be overcome. Figure 3.1 provides an indication of the factors that influence and constrain growth of Commercial capture fishing in the UK. The subsequent sections explore these issues in more detail.

[128] MMO (2018) UK Sea Fisheries Statistics, 2017

Figure 3.1: At-a-glance assessment of sector constraints for commercial capture fishing

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	-	-	- -	-	-	-	-
England	-	-	-	-	-	-	-
Northern Ireland	-	-	- - -	-	- -	+	-
Scotland	- -	-	-	-	-	-	-
Wales	-	-	- -	-	-	+	-

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Human resource and access to labour and skills

4.51 Attracting workers to Commercial Capture Fishing is challenging largely due to perceptions around difficult working conditions, the physical demands of the job and income levels. It is particularly challenging to attract young people to the sector. In conjunction with an ageing workforce[129], this presents a considerable constraint on the sector.

4.52 As a result many fishing fleets rely on EU and increasingly, international workers. This presents a particular challenge for the mainly pelagic and shellfish fisheries fleets and vessels on the west coast of Britain[130] and in Northern Ireland, as well as for inshore fishing, in that there are restrictions on where non-EU fishers can work (not within 12 nautical miles of the coast). It puts the east coast and offshore (demersal) fleet at a distinct advantage.[131] Because the west coast is largely enclosed, then it is mostly not 'offshore' fishing like on East coast, where there is a bigger allowance for overseas workers on offshore boats under immigration law.[132] In a situation where there may be fewer EU nationals working in the sector in future,

[129] 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

[130] https://www.heraldscotland.com/news/17859495.immigrations-rules-putting-scots-fishing-industry-risk/

[131] See: Seafish (2019) *2018 Employment in the UK Fishing Fleet report*; and Marine Scotland, (2015) Scottish Sea Fisheries Employment 2015 https://www.gov.scot/publications/scottish-sea-fisheries-employment-2015/pages/5/

[132] e.g. https://www.heraldscotland.com/news/17859495.immigrations-rules-putting-scots-fishing-industry-risk/

but with no loosening of rules on non-EU nationals, this would have the effect of constraining a sector reliant on immigration channels to supplement its workforce.

4.53 Where there is no available workforce (local or otherwise) to crew boats, there is anecdotal evidence that boats are being sold, therefore reducing the capacity of the sector, and the economic benefit for some fishing communities. This weakens coastal economies, and serves to further concentrate economic benefit in a smaller number of companies and locations.

Environment and natural resources

4.54 Ensuring the sustainability of supply has been a longstanding issue for Commercial Capture Fishing. Past experiences, such as overfishing of cod in the 1980s demonstrated the need for a healthy fish population, and the impacts, such as sector recession, if this is not well managed. Whilst stock levels of some species have recovered in recent years, climate change is bringing a new set of challenges. There is uncertainty around the scale and speed of change, but effects span increased incidence of harmful algal blooms (HABs) and disease events, shift in fish stock patterns, and the viability of fish stocks all brought on by change in water temperature, aquatic conditions and currents.

4.55 There is a market failure here in terms of imperfect information. A number of stakeholders identified that a lack of understanding on the impacts of climate change, as well as limited understanding of the marine space, is hampering efforts to plan and respond effectively. Monitoring is improving, but there is still a perception that there is insufficient data to fully understand climate change and the impact on specific fish stocks, and the viability of fish stock more generally meaning that policy and decisions are based on incomplete or partial data:

> "The North Sea should be the best understood in the world, but it is still a hotch-potch."

> "Current data [for Northern Ireland] is focused on quotas for capture fisheries and aquaculture for statistics. There needs to be cross-sectoral and consistent data gathering to feed…an ecosystem baseline."

4.56 As a result, there is a risk that fisheries stocks cannot be managed effectively, negatively impacting both the productivity of the sectors, and the sustainability of natural resources. There is a consensus across all stakeholders that much better data and understanding is required in order to enable the industry to proactively address climate change issues, as well as more effectively manage fisheries. This requires an industry and pan-government agency approach that is driven not just by compliance, but by industry and environmental need. This was raised as a particular challenge for Northern Ireland fisheries.

4.57 Another challenge presented by climate change is increasingly erratic and adverse weather events. This can prevent boats going to sea, reducing the window

of opportunity for sailing. This places pressure on the fishing fleet to catch sufficient fish in less time overall:

> "Fishing activities can be restricted by weather conditions, and we are increasingly experiencing lots of prolonged spells of adverse weather."

> "Due to [increasing] storm frequency and intensity, would a boat [be able to] go to sea in 20 years?"

4.58 In addition to environmental challenges, there is evidence of pressure on inshore fishing in some areas. Industry stakeholders in Wales noted that whilst stocks in Welsh waters are generally well-managed and high-quality with a potential to revive some local fisheries, in some areas, such as in North Wales, stocks are under pressure from over-fishing and increased prevalence and efficiency of equipment:

> "Things have definitely got worse…in North Wales. There is less fish, but better, and more, fishing gear."

4.59 The distribution of fishing quotas has been contested within the UK home nations and across inshore and offshore sectors, on the basis that some areas are perceived to be missing out on investment. For example, some stakeholders in Scotland reported that due to the majority of fishing quotas being taken up in the North East of Scotland, ports on the Firth of Clyde, South East Scotland and elsewhere do not then invest in port and harbour infrastructure. Further, the concentration and degree of foreign ownership of the fleet and quotas have been under scrutiny, due the added negative impact this has on the (lack of) distribution of economic benefits in local economies. Much of this is subject to change through Brexit, with the UK white paper on fisheries[133] setting out initial policy direction.

Infrastructure to support the commercial capture fishing sector

4.60 There are long-term structural infrastructure constraints that can limit access to markets for fishing businesses. These market failures are largely a function of geography: fisheries and the ports at which they are landed are far removed from the markets they serve, and in some cases from the downstream supply chain, including wholesale retail and primary processing. In Wales and the East of England, the distance from ports to motorways and major transportation hubs is a barrier to direct access.

4.61 Ports serving the UK's west coast fisheries, and also those ports serving the smaller, pelagic fleet elsewhere in the UK also have a number of infrastructure challenges. A lack of shared port facilities such as gear to land catch from some boats, or adequate storage facilities (access to cold storage is dealt with in relation to Seafood processing, below, paragraph 4.118 onwards) means that landing catch at certain ports can be problematic. This appears to be a particular challenge in Wales

[133] https://ukandeu.ac.uk/governments-fisheries-white-paper-what-it-does-and-doesnt-say/

with Welsh stakeholders reporting that many boats use Milford Haven to land catch despite being registered elsewhere, incurring additional cost. The lack of transport infrastructure in South West and West Wales also means that some catch is landed in South West England instead.

4.62 The market failure here is one of public goods, and businesses unable or unwilling to invest in shared infrastructure. This results in a lack of landing capacity and capability, which clearly impacts on the distribution of economic impacts for Commercial Capture Fishing. Stakeholders report that not addressing the issue of landing capability and access to market will limit opportunities for smaller ports and fishing businesses to access markets, and also to take advantage of different future catch quota arrangements.

4.63 An entirely different infrastructure challenge faces Shetland, a major centre for landing offshore fishing catch from the North Sea and North East Atlantic. Whilst there is good capacity and high-quality facilities on Shetland which are currently being expanded through new fish markets at Scalloway and Lerwick, there is a reliance on ferry capacity and frequency of sailings to transport landed fish from Shetland to mainland UK. The routes to the North Isles is also highly subsidised, meaning that other operators will not run the route on a fully commercial basis, further restricting capacity. This also affects other areas where there is a dependency on finite ferry capacity as part of the logistics chain. It is a serious constraint to the growth of more remote fisheries ports, limiting routes to market for time-sensitive goods. Addressing this market failure would require additional public subsidy to increase ferry capacity for freight.

Financial support for fisheries

4.64 Access to finance is a major constraint to some parts of the Commercial Capture Fishing sector (e.g. smaller pelagic fleet), particularly for potential new entrants who struggle to buy quota. This market failure is a result of information asymmetry between lenders and the businesses and entrepreneurs. The wider financial outlay for new market entrants, across cost operation, boats and associated kit, licences, can be prohibitive, requiring finance that is not consistently available. These costs can be difficult to offset against the variable income derived from landings. This is compounded by difficulties in accessing finance from banks and lenders. Where banks do lend to the sector, it is often limited to 50% of the total investment; however, banks will generally not recognise fishing quotas as an asset, so do not take it in to account when considering loan applications.

4.65 As a result, there is a lack of required investment in the sector, which means that equipment and vessels are not replaced or updated. Also, new entrants are deterred from joining the sector. This ultimately serves to constrain the productivity and competitiveness of the sector.

4.66 There have been some attempts to address this through community loan funds, but the geographical provision of these financing models for inshore vessels is

poor, and some have fallen foul of State Aid rules. For example, a loan guarantee scheme was established in the Western Isles to support start-up fishing businesses, or those wishing to expand. It is similar to approaches used elsewhere, such as Norway. However, State Aid rules led to a change in the fund, meaning it was not as effective in supporting small fishing businesses. Similarly, Shetland Islands Council established a loan scheme as part of its investment fund, providing loan funding to match bank or commercial lender investment. Whilst this facility still exists, lending activity has declined in recent years, though reasons for this are unclear.

Technology, equipment and innovation

4.67 As noted above, there is an increasing need to monitor the marine environment and fish species stocks. Monitoring is important for compliance on catch and discards but can also help to improve efficiency of operations and understand the impacts on the environment. This is to ensure the long-term sustainability of stocks and inform real-time information of catch. This latter point is important to enable greater vertical integration with Seafood processing (see below).

4.68 However, there is a challenge in reconciling increasing need and growing support for auditable and real-time information systems, and concerns from fishing businesses over surveillance. In short, this is an information failure, which impacts on the ability to accurately respond to and manage market demand for catch (so that it remains largely supply-driven), and stock management is done on the basis of imperfect or impartial information. Some stakeholders suggested that negative historical experiences of information sharing and monitoring on the part of fishing businesses have led to a higher degree of resistance than would otherwise be the case.

4.69 There is also a market failure in terms of the rate of innovation adoption: the uncertainty or lack of knowledge around new technologies, and the investment commitment required to trial and deploy means that businesses are reluctant to adopt new kit. Technological innovation in fisheries has been developing with support from organisations such as MMO and Fisheries Innovation Scotland (FiS), however some stakeholders in England and Scotland consider that the adoption of innovation in fisheries lags other sectors. They report that more could be done to support more widespread trialling of new and innovative fishing gear. Some fishermen appear to be reluctant to trial new gear at sea, as they are concerned that it does not meet legislative requirements. This acts as a ‘bottleneck’ in terms of innovation adoption, and thus impacts on the productivity and efficiency of the sector.

4.70 The precautionary principle, and a reluctance to ‘implement, monitor and manage’ with relation to fish stocks is constraining the identification of more efficient and selective means of fishing, and the implementation of new technologies at an earlier stage. Establishing trial licences or zones would help to address this issue and lead to more rapid identification of innovations and so more efficient and sustainable fishing methods that reduce the impact on the marine environment and seabed, as well as reducing by-catch.

4.71 A challenge facing fisheries in some areas is an ageing fleet, which limits efficiency and productivity. Despite some evidence of new investment in Scotland and England in particular, a considerable proportion of the fisheries fleet, particularly in Northern Ireland and Wales is old, inefficient and polluting. At the UK level, over half of the fleet (56%) entered service in 1990 or earlier; three in ten vessels entered service before 1980. In Northern Ireland around two thirds of the Northern Irish fleet entered service in 1990 or earlier and almost four in ten vessels entered service before 1980 demonstrating how acute this issue is here.[134] Evidence from consultations indicated that for smaller businesses, there is a market failure in terms of lack of finance to invest. In some cases a lack of clear business succession means that current vessel owners, as they reach retirement (given the older average age of age of the fleet workforce, as discussed above), are less inclined to self-fund investment in new or upgraded vessels and equipment, and corroborating MMO data on vessel age this is a particular challenge in Northern Ireland. As a consequence the fleet is less efficient, which negatively impacts on the productivity of the sector.

4.72 On the supply side, the ability of domestic boat production to meet demand is also a factor in the age of the fleet. Evidence from the consultations indicates that whilst orders for new vessels are increasing[135], builders such as Parkol in Whitby and Macduff in Aberdeenshire are struggling to meet demand. This results in the fleet operating with ageing and inefficient vessels and equipment, which constrains capacity and productivity. Also, 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 the fishing vessel building industry – though this assumes that the comparative advantage that other countries have is not such that any manufacturing gains would not be outweighed by the cost of production for a domestic vessel.

Community relationships

4.73 A recent study[136] in Scotland has supported long-held beliefs that inshore fishing is intimately connected with the social capital and sense of community in many coastal areas. This can in turn translate to positive associations for marine tourism – e.g. 'authenticity'. However, this relationship or 'value' depends in turn on the degree of involvement local communities have in the fishing activity itself. As noted above, in recent years the industry has often employed migrant and overseas labour. This is potentially causing a disconnect between the communities that support, and are supported by, the Commercial capture fishing industry, if that labour is not then a part of the communities. Such a disconnect can affect the supply of local labour to the Commercial capture fishing industry as discussed above. This

[134] MMO (2018) UK Sea Fisheries Statistics, 2017

[135] e.g.: https://www.thenational.scot/news/17657381.whitelink-seafoods-invests-in-new-scallop-vessel-with-rbs-funding/

[136] https://www.masts.ac.uk/research/emff-sifids-project/

negatively impacts on the viability and ultimately the resilience of the sector. In turn, where fishing declines in local areas, this weakens the distribution of impacts.

Aquaculture

Sector overview

4.74 There is an increased demand globally for protein, of which fish and seafood is a key component. This is being driven by global population growth and rising affluence in developing countries. A key element of meeting this demand is increasing sustainable production through aquaculture. The growth aspirations of the aquaculture sector across the UK, and indeed elsewhere globally, reflect this increasing demand.

4.75 However, as identified in Chapter 2, there is a growth challenge. Aquaculture faces a number of inter-related challenges and market failures that serve to constrain the sector, and prevent it realising the growth opportunities presented to it. As Figure 3.2 shows, there are a range of factors that serve to constrain growth in the UK's aquaculture sector. These are set out in more detail in the following sections.

Figure 3.2: At-a-glance assessment of sector constraints for aquaculture

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	- -	- -	-	- -	-	-	- -
England	- -	-	-	- -	-	- -	-
Northern Ireland	-	-	-	- -	-	+	-
Scotland	-	- -	+	- -	-	-	- -
Wales	- -	-	-	- -	-	- -	-

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Market Failure: Human resource and access to labour and skills

4.76 There is a significant labour market failure in the aquaculture sector. Across the UK, the challenge is a labour shortage, at least in part due to the profile of the sector. Aquaculture as a career option has a lower profile than some other sectors and as identified through consultations and other related research[137], is often

[137] ekosgen, Imani Development for HIE (2018) *Skills Review for the Aquaculture sector*

perceived to be less attractive as an employment or career option. This makes recruiting people difficult.

4.77 Workforce challenges in England, Wales and Northern Ireland are predominantly concerned with labour supply (manpower). Specific skills shortages and needs, as well as labour supply, are a key issue for aquaculture companies in Scotland, due to the scale and nature of the sector.[138]

4.78 To counter the issue of attractiveness and labour supply shortages, an aquaculture company in England has introduced a staff rotation system as part of its expansion plan. As well as addressing labour supply challenges, it is designed to facilitate skills transfer by allowing staff to experience different roles across the company.

4.79 The growth, and growth aspirations of the aquaculture sector are driving increased demand for skills in production activity although there is also unmet demand in other areas such as processing and the wider supply chain. For example, to increase production levels, companies need to address issues regarding fish welfare and environmental stewardship. Reflecting the importance of this, the aquaculture sector needs people who are skilled in up-to-date approaches to fish husbandry, fish health, feeding and biology. However, these skills are in short supply and employers face gaps.

4.80 Producers are looking at how technology can be applied to improve and grow production which is creating a need for more technical skills. The need for technologically and digitally skilled staff is particularly acute in finfish as a result of expansion, automation and new models of production. Whilst shellfish producers in the UK tend to be lower-tech, there is an increasing prevalence of technological solutions to increase production – and therefore an increasing demand for technological skills. Demand for skills is only expected to increase, with more specialist and niche skills required as the industry develops and adopts more sophisticated systems and innovative techniques and technology. These are lacking in the current workforce and will be increasingly important for the future sustainable development of the sector.

4.81 There is a shortage of other skills required in aquaculture such as engineering. These skills are also in high demand elsewhere in the economy so aquaculture is competing with many other sectors to recruit engineers. This adds to the pressure, particularly in areas where aquaculture is competing for staff with higher value, and higher paying sectors such as oil and gas.

4.82 Sector growth and consolidation in Scotland, particularly in finfish, means that leadership, organisational management and wider business skills are in high demand

[138] Ibid.

as businesses have become larger and more complex. This skills shortage means that effective business management to drive growth can be a constraint.

4.83 For the shellfish sector, the fact that a high proportion of the businesses are micro and often owner-occupied can make succession planning difficult, with a lack of new people entering the sector to take over the running of businesses. As such, the constraint amongst shellfish businesses is one of business continuity.

4.84 Aquaculture companies face skills shortages so as well as competing with other sectors for staff, businesses within the sector are competing with each other *within* the sector. This leads to churn, with companies competing for the incumbent workforce in a tight sectoral labour market. A further consequence is that businesses are unable to fill skills gaps: if businesses don't have the workforce to fuel growth, then they are unable to ensure that production can meet demand, and thus cannot benefit from increased demand. It was identified through consultations that aquaculture companies *could* raise production to meet demand but integral to this will be an adequate and sustainable skills supply.

4.85 The UK's aquaculture-related education is internationally renowned, but there is an inadequate supply of courses and qualifications that are specific to aquaculture – both finfish and shellfish – across the UK. This is a constraint: the ability of education and training providers to produce skilled and qualified entrants for the aquaculture sector is an important factor in meeting the skills challenges set out above.

4.86 To tackle this skills supply challenge, many aquaculture companies have developed internal training programmes and qualifications. However, these are not transferable, or consistent across companies: training is not accredited, so training from one company is often not accepted at another. If an employee moves to a new company, training is repeated. This results in duplication of effort, and thus inefficiencies, and so compounds the issue of skills as a constraint on growth by negatively impacting on the productivity of the aquaculture workforce.

Environment and natural resources

4.87 There are two aspects to consider here: the extent to which environmental conditions impact on the economic growth of the aquaculture sector; and how the sector impacts on the marine environment.

4.88 In terms of how environmental conditions impact on the sector, the main challenge is undoubtedly climate change. Biological conditions in the UK's water are changing and this is likely to continue for the foreseeable future. Climate change is impacting and will continue to impact on the species that can be farmed in different parts of the UK. Water quality impacts on the bivalve sectors in Northern Ireland and Wales in particular, as mentioned previously at paragraph 3.24. Although ocean warming may create opportunities for aquaculture to diversify into new species, evidence from research consultations identified that the aquaculture sector may be faced with the challenge of switching production to different species (capital

immobility), for which there is a market. If the sector does not respond to the consequences of climatic changes efficiently and effectively, it will be at risk.

4.89 Management of disease and biosecurity of fish stock remains a significant challenge for aquaculture production, and a constraint to growth. The industry is facing issues of sea lice, algal gill disease and other pathogens, particularly finfish production in Scotland, and it is anticipated that climate change will exacerbate these. Issues of fish health impact on the security of supply; this impacts on the abilities of companies to grow by undermining certainty of and confidence in supply, and exacerbating annual variations that arise due to the industry's dependency on biophysical conditions. It also negatively impacts on the quality of supply in a sector where premium quality and provenance are key competitive advantages for the UK. It threatens the position of the product as a high quality one that attracts a premium price. Fish health, welfare and good environmental stewardship are therefore key drivers for innovation. Whilst there is a significant amount of research being undertaken in this area by the Scottish Association for Marine Science (SAMS), Scottish Aquaculture Innovation Centre (SAIC) and others, solutions currently being developed and trialled are not yet proven in terms of effectiveness and market readiness.

4.90 Welfare and environmental stewardship, and its impact on the marine environment are important considerations for aquaculture, e.g. interaction with wild species. Negative externalities such as pathogen or parasite transmission, or environmental degradation arising from farm waste or pollution is a key focus for businesses, strategic bodies and communities.[139] Alongside the negative environmental impacts, these externalities can constrain growth by reducing production yields, damaging the premium brand reputation and increasing the mortality rate on farms. Failure to address this critical market failure will negatively impact on the ability of companies to farm in current locations, and create barriers to gaining consent for relocation or expansion into new sites. This therefore poses a significant threat to production and growth capabilities.

4.91 There can also be challenges where aquaculture shares space with other marine uses, for example marine tourism. An example is where leisure boat trips pass through aquaculture production sites, impacting on operations. This was cited in the research as a problem in both South West England and Scotland. This therefore constrains production growth, to the extent that mitigation measures or policy decisions are required to overcome the challenge.

4.92 The pressure on the marine environment as an asset from a range of user groups and coupled with the growth potential of aquaculture, means that the sector must consider expanding in to new sites. Currently the majority of production sites are in near-shore or inshore waters but availability of new inshore sites is constrained. There is a degree of geographical immobility from a market failure point

[139] https://www.theguardian.com/uk-news/2019/aug/12/proposed-salmon-farm-raises-environmental-concerns-in-hebrides

of view: businesses are not readily able to relocate. Access to new trial sites in other locations is limited, either by management systems for other types of use, or environmental designations.

4.93 In response to the lack of in-shore sites, the sector is increasingly looking to more exposed locations further off-shore. 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 adapted to cope with the conditions, for example wave movement, deeper water and wind. If aquaculture sites are located further off-shore, they may be closer to wild fisheries and there are concerns about the implications of interaction of farmed and wild fish and possible transfer of disease and pathogens.

Infrastructure challenges for aquaculture

4.94 Whilst this report identifies a number of infrastructure challenges common across marine sectors, the research did not identify any additional infrastructure challenges specific to aquaculture.

Financial constraints in the aquaculture sector

4.95 There are a number of structural market failures related to access to finance for aquaculture companies in the UK and so can constrain investment in innovation and expansion.

4.96 Where a UK aquaculture operation is part of a much larger international company, the UK-based operation can access finance from the parent company or group and can access non-UK sources (i.e. internal financing). This happens most frequently in larger finfish (salmon) production companies in Scotland, but Scottish-based operations must then demonstrate competitiveness within an international portfolio of production.

4.97 However, these types of financing options are not available to smaller, shellfish producers in the UK. One proposed solution reported by consultees in England was to pool aquaculture expansion or start-up projects. By creating a critical mass of activity, this would help to secure investment by establishing a larger pool of business capital, and de-risking the investment for investors. There may be some merit in this: the consolidation through a co-operative approach of shellfish producers in Scotland has served to strengthen the shellfish aquaculture industry there. Pooling of resources through collaborative approaches would also enable an otherwise disparate sector of small and micro businesses to better access market opportunities in a co-ordinated manner. It also helps to reduce risk for potential investors in the sector. The challenge of this is in overcoming perceptions of competition, and any potential search cost in bringing aquaculture operators together.

4.98 For smaller and non-multinational, domestic businesses, financing challenges constrain the growth potential, which in turn restricts market share for the UK

aquaculture sector. This puts UK businesses at a distinct disadvantage relative to competitors and undoubtedly has a detrimental impact on future growth prospects.

4.99 This is a significant challenge for UK aquaculture businesses and a constraint to growth. Banks and investors in the UK do not have an adequate understanding of the sector, and they often have imperfect information which creates an information asymmetry problem when making lending decisions, for example about the structure and asset base. This lack of understanding means that they are risk averse in making investment decisions in aquaculture, so limiting the flow of and routes for investment into the sector.

4.100 Evidence from consultations confirms that the industry's assets are generally not assessed as viable collateral for loans. Other parts of the world that the UK aquaculture industry competes with do not face this issue which impacts on UK businesses' ability to compete. Consultations also clearly demonstrated that lack of access to finance is a significant barrier to market entrants because investment is particularly difficult to secure for constructing and establishing new farms.

4.101 The equipment required for aquaculture production is often highly specialist and expensive, but with little re-sell value, particularly in a sector typified by a small number of large enterprises, and a large base of micro businesses. This can deter potential investors from investing in production companies and equipment supply chain companies. Industry equipment is not mortgageable. Banks often demand personal guarantees to secure investment which can be a barrier for business owners. Only a small number, such as Clydesdale Bank, have any appetite to invest in aquaculture companies. Thus few companies seek investment from UK financial institutions: Scottish Sea Farms are one of a small number that are doing so, for its hatchery site at Barcaldine near Oban.

4.102 This lack of access to finance means that the only options available to aquaculture companies in the UK tend to be government grants, or self-financing.

4.103 Alongside access to finance, securing affordable insurance can also be a constraint, deterring entrepreneurship in the sector by increasing the risk to potential business owners. As one consultee commented:

> "[Producers] can't get insurance for the kit that they purchase – insurers require that farms have to be running for at least a year with no problems before insurance can be put in place."

4.104 Countries that the UK competes with in the aquaculture market have more positive approaches to investing in the sector which more effectively support the sector's development and expansion. For example in Norway, equipment and licences are accepted as assets by banks during the loan application process. This makes Norwegian companies more able to invest and therefore respond and scale up production to meet global increases in demand. This investment model is being exported, with Nordic banks offering finance to aquaculture businesses in Shetland.

This is a missed market opportunity for UK finance businesses, and also public sector lenders.

4.105 In the UK there is a need to examine access to finance for the aquaculture industry and the structural barriers. The aim would be to better understand it and open up more financing options.[140] This will help to reduce the perception of and attitudes to risk by financial institutions, and provide greater access to finance options to aquaculture production and supply chain businesses, so better supporting company and sector growth.

Technology, equipment and innovation

4.106 Research and innovation in aquaculture is partly driven by the need to address biological challenges and mitigate environmental impacts. Examples of R&D and innovation include new systems and automation as businesses seek to improve their productivity and competitiveness, for example automated feeding and using digital technology and remote sensing to monitor fish stocks, e.g. Roving Eye Enterprises in Orkney.

4.107 The fact that a high proportion of finfish aquaculture in Scotland is owned by a small number of international companies means that science and research often happens outside of the UK and innovations and solutions are imported from for example, Norway and Canada. This is a challenge for the UK sector as the high value R&D activities are taking place outside of the country so there is a deficit of domestic technological capital for aquaculture and so presents a constraint to growth in the UK industry. There is therefore a need to consider how UK aquaculture businesses can be encouraged and supported to grow, and investing in R&D and innovation in the UK is one way of achieving this. There are some positive examples. For instance, UK company Gael Force Marine is an innovator in aquaculture engineering, building on pen production in Inverness and Oban and now venturing into barge manufacturing in Lochaber.

4.108 The drive towards more exposed sites means that existing production equipment is not viable as it cannot withstand the more extreme marine conditions. Along with the need for new skills, the need for new types of equipment is a key challenge for the aquaculture industry if it is to successfully expand in to more exposed locations. It is driving research and innovation in terms of developing the equipment, expertise and technology required to operate in exposed locations. Examples include cage design solutions, offshore renewable power generation, remote cameras and sensors to monitor higher rates of wear and tear, use of drones, and automated feeding systems.

4.109 However, the cost of developing new systems and equipment, and demonstrating market viability are high, and arguably prohibitive currently. This is a barrier to investment amongst aquaculture companies, and evidence identified through the research indicates that, outside of large multinational companies,

[140] Imani Development, SRSL/HIE, SAIC (2017) *Scottish aquaculture: a view towards 2030*

businesses are reluctant to invest at the scale required. Public sector intervention is required to support the innovation process, reduce development costs and bring solutions to market. As discussed, these developments also have associated skills implications, in terms of both R&D and implementation/operation.

4.110 Recirculation aquaculture systems (RAS) are currently being used to produce salmon and other species in Canada, USA and China. They are, by some, considered to be a solution for both finfish and shellfish production in the UK. However, they are perceived as risky and high cost relative to marine production as the technology is still relatively early stage, and so there is an information failure that discourages investment: the cost of equipment and perception of risk together impacts on the adoption of RAS as a means for aquaculture production. This is in part due to the degree of understanding on issues such as temperature control, waste management and energy use versus marine production. Generally, Closed System Aquaculture (CSA) is more highly controlled than open systems, and are already used in the hatchery and smolt production processes. However, how much RAS and other CSA systems will eventually supersede open marine production, either land-based or closed/semi-closed systems in the sea, remains to be seen.

Co-ordination failures and challenges

4.111 Aquaculture is subject to a number of co-ordination failures. Arguably the most prominent of these is conflict with other marine uses and activities. The sector is often viewed more negatively compared to other marine uses that are deemed to be less intrusive with less of an environmental impact. The growth of the sector will require the sector to be accepted within shared marine waters by all stakeholders, unless, for example, RAS fundamentally changes production. This acceptance and support will largely depend on how the industry responds to the environmental challenges it faces, and mitigates its own environmental impact, as discussed above, to ensure a more sustainable mode of development for the sector. These issues have been considered by a Scottish Parliamentary inquiry that reviewed the impacts of salmon farming.[141]

4.112 Another co-ordination failure arises from the perception of aquaculture by downstream sectors, for example across the accommodation and food services sector. Often, there is limited understanding of what aquaculture is or what it can produce compared to commercial capture fishing. Stakeholders in England were of the view that the food service industry in particular is not aware of the quality, provenance and traceability of aquaculture-produced seafood, as well as aquaculture's ability to harvest to meet needs – it can be much more demand-driven than commercial capture fishing, and therefore can be more responsive to industry and consumer needs. This means that restaurants and hotels incorrectly perceive it to be an inferior product. This acts as a barrier to the sector realising growth and market opportunities, particularly in domestic markets.

[141] https://www.parliament.scot/parliamentarybusiness/CurrentCommittees/107588.aspx

4.113 Evidence from industry stakeholders in England indicates that the capability to cultivate a variety of species using RAS will be available in the short term.[142] Currently the cost of production is high and energy costs – particularly where companies are aiming to cultivate warm water species – are prohibitive, as noted above. To maximise the efficiency of RAS production, it would be logical to locate RAS operations close to markets, power supplies and transport/logistics hubs rather than in remote coastal locations where the industry is currently located, by necessity.

4.114 Standalone and land-based production would mean a step change on a number of fronts, for example access to a larger labour pool and reduced time and cost of routes to market. However, such a significant restructuring of the industry would be subject to geographical immobility challenges. If it meant that open-water marine aquaculture did not grow and in fact declined, then there would be significant implications for communities where aquaculture is a key part of the economy. In turn, this could increase regional disparity and erode the socio-economic resilience of already fragile remote rural areas.

Community relationships and social licence

4.115 Aquaculture's social licence[143] 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[144], management of farm stocks and response to predation.[145] This has served to undermine how the industry is perceived by the public, and undoubtedly also negatively impacts on how the industry is viewed as an employment and career option.

4.116 There is a clear need to address issues around fish health and welfare, and to be seen to be doing so, if social licence is to be maintained and developed. This will need to be done in conjunction with clear, evidence-based communication and open engagement about how the issues are being addressed and the outcomes. Aquaculture stakeholders in Scotland in particular demonstrated concern that public sentiment and organised lobby groups are influencing industry and political decisions but that they are not always based on sound evidence.

4.117 There is no doubt that aquaculture remains a very important sector from a social perspective as well as an economic one. It is a key and a relatively high-income employer in rural areas where employment and career opportunities tend to

[142] This views appears to be supported by recent media reports on the matter, e.g.: https://www.theguardian.com/environment/2019/aug/07/farmer-produces-ethical-king-prawns-in-a-lincolnshire-field

[143] The level of acceptance or approval by local communities and stakeholders of businesses and their operations

[144] https://www.theguardian.com/business/2018/oct/29/campaigners-call-for-temporary-ban-on-new-scottish-fish-farms

[145] https://www.scotsman.com/news/environment/fish-farms-kill-more-seals-as-industry-tries-to-save-salmon-1-4593698

be limited. The opportunities for higher value added jobs will grow with advances in technology in aquaculture. There have been some good examples of co-investment between the aquaculture industry and host communities in terms of housing, as well as in other infrastructure and services such as digital connectivity. For example, the development of the Scottish Salmon Producers' Organisation (SSPO) Community Charter[146] shows how the process of community engagement should work and where benefits can be seen for both communities and farming companies. The Charter demonstrates the recognition by industry of the need for aquaculture sites and their staff to be more sensitive to the local community in which they are based.

Seafood processing

Sector overview

4.118 Seafood processing has an important role in meeting the increasing global demand for protein. It contributes to the security, integrity and provenance of UK seafood products. Seafood processing is interlinked and increasingly integrated with both aquaculture and fisheries and is often vertically integrated, particularly in aquaculture. The seafood processing sector is now increasingly involved in the drive towards traceability of product, whereby the processor links the buyer and primary sourcing. In turn, this is causing a race towards control of supply as market linkages become more contract-based than open market sourcing.

4.119 The seafood processing sector is relatively stratified. There is a high proportion of small primary processors, serving a wholesale market. These often have simple operating models with low levels of investment. Mid-sized processors tend to supply regional retail and export markets, often handling a wider range of species. The larger processors are small in number, but are often large enterprises (non-SME), with a high degree of value-added processing undertaken. They supply the major multinationals and serve large international markets.

4.120 Whilst some of the challenges facing seafood processing are shared with other marine sectors, they manifest themselves in a particular way in seafood processing. There is a concern that the challenges faced by seafood processing means that the sector doesn't have the capacity to respond to increases in demand or in supply and production. As identified in Chapter 2, there is a growth challenge for the sector. The following sections examine the specific challenges and constraints in more detail.

[146] http://scottishsalmon.co.uk/wp-content/uploads/2016/09/community_charter_2016_digital.pdf

Figure 3.3: At-a-glance assessment of sector constraints for seafood processing

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	- -	-	- -	-	-	-	- - -
England	- -	-	-	-		-	- - -
Northern Ireland	-	-	- -	-	-	- -	- - -
Scotland	- -	-	-	-	-	-	- - -
Wales	- -	-	- -	-	-	-	- - -

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Human resource and access to labour and skills

4.121 Seafood processing has a significant labour market failure. There is a disproportionate reliance on overseas workers (both EU and non-EU), often provided through employment agencies. However, this does not adequately meet the labour shortage in the sector. As identified in the research through consultation with stakeholders, there is a key challenge in access to the required labour force for the seafood processing sector. Across all parts of the UK, there is a reported lack of seafood processing workers, and often it is the local workforce that is in short supply. Stakeholders, especially in Scotland, reported that the long-term reliance on a non-domestic workforce to try and address this shortage means that the sector is not as closely connected to local communities. This disconnect has negatively impacted on recruitment from local communities. Evidence obtained through consultations suggests that in some seafood processing companies, more than three quarters of the workforce are non-UK nationals.

4.122 This has resulted in a labour shortage not just of lower skilled roles, such as gutting, filleting, portioning, etc. but also in science, research, product development and management. Where processing operations are in rural areas, lack of (affordable) housing and services coupled with remoteness encourages people to move out of the area and makes it harder to attract people in. This is a key barrier to employment and a driver of out-migration from rural regions, especially by young people. This further constrains access to the labour required by the sector. As with aquaculture and commercial capture fishing, seafood processing competes with other sectors for staff, and is often a less attractive option. Consultees noted that this is due to the nature of the work involved, working environment, pay/salary levels, etc., perceived or otherwise.

4.123 Consequently, some, larger processing businesses are looking to automation as a means to tackle the labour shortage. Automation may address some of the challenges by changing work processes and reducing the need for particular skills. However, this is likely to cause structural changes in the workforce, and new higher-level skills will be in demand. Stakeholders anticipate that there will be competition for these skills with other sectors as well, since upskilling across the incumbent workforce will not be a suitable solution.

4.124 The use of agency workers and reliance on non-UK workers also has other consequences. Consultees in England reported that there is a lack of training for and skills transfer between existing workers, meaning that there is a risk of skills gaps and shortages developing. There is also no shared and recognised training between employers, with companies delivering their own in-house training programme, as reported by Scottish stakeholders. This often means that training is repeated when a staff member moves from one company to another. This can impact on the productivity and efficiency of seafood processing businesses, and unnecessarily increases the training costs for businesses.

Infrastructure capital

4.125 There are deep-rooted infrastructure challenges facing the seafood processing sector that are a constraint to growth. They are particularly challenging for smaller processors and processing operations, for example in Wales and Northern Ireland, where there are very few, if any, large processors, as well as in smaller processors in England and Scotland.

4.126 There is challenge in business land and premises available to seafood processors. This was reported by consultees as being a particular challenge for small processing businesses, which are constrained by a lack of internal capacity or physical site space to expand and modernise their operations, often due to their location on small harbours or industrial sites. Modernising existing sites, or developing and relocating to new sites are capital intensive, and often beyond the reach of small operators, either due to lack of finance (a market failure), or lack of available sites. This restricts the functions and processes that they can carry out.

4.127 As a highly perishable product, access to temperature-controlled storage facilities and environments is essential for seafood, but there is a lack of cold storage capacity. Where individual companies lack access to their own facilities, this is an equipment issue, but stakeholders reported that there is a market failure in terms of available shared facilities that smaller processors can access. This structural issue is a particular challenge in Wales, where, apart from a small cold storage facility in Swansea marina, access is very limited. In Scotland, and especially in the North East of Scotland, installing thermal cladding or refrigeration equipment increases business rates, meaning that smaller companies often struggle to invest in the necessary equipment. One large England-based processor reported there are also short term issues because of Brexit as companies are stockpiling products and using more cold storage space. The overall effect here is one of constraining capacity for

handling processed seafood, and therefore the ability of seafood processing companies – and thus the sector – to grow.

4.128 Restricted access to adequate facilities and equipment also impacts negatively on environmental health standards. Poor quality facilities increase the risk of poor environmental health. Despite the availability of funding to address the issue of facilities and environmental health quality, for example from Seafish to build up quality and accreditation, evidence identified through consultations suggests that a number of operators may be operating below industry standard. The risks could have a detrimental effect on the seafood processing sector and its international reputation for quality, provenance and integrity. This is a negative externality and hence a market failure, as the poor standards or 'rogue' trading of one firm could impact on the brand value of UK seafood and therefore on all other firms in the sector, as illustrated by the following comment:

> "These operators are frustrating the rest of the industry, and have a detrimental effect on the sector… [there is] a reputational risk."

4.129 This can arguably negatively impact perceptions of UK seafood in comparison to competitor countries such as Norway. Such an effect would undoubtedly undermine the UK's competitiveness on the global stage as a result.

Financial capital

4.130 In line with other marine sectors, access to finance for Seafood processing can be limited. This is a structural market failure that constrains investment in expansion, upgraded facilities or innovation in products and processes. As identified through research with Scottish and English stakeholders in particular, companies struggle to secure investment because banks consider investment to be too risky: there is also a lack of understanding on the part of lenders of investment and equipment requirements to grow seafood processing businesses.

4.131 In some instances, access to finance may be problematic because equipment is too specialist and thus has little re-sell value, i.e. it is not mortgageable, though there are some companies[147] that deal in used processing equipment. In other cases, many companies are effectively prevented from purchasing new equipment even if they are able to access financing. Whilst seafood processing equipment and technology often comes from international suppliers, for example in Germany or Iceland, asset finance requirements mean that kit has to be purchased in the UK. To overcome barriers such as this, some industry bodies are in the process of developing investment toolkits to support businesses in accessing asset finance, for instance Seafood Scotland.

[147] e.g. Boyd Food Machinery in Buckie: http://www.boydfoodmachinery.com/

4.132 It was also reported through the research that the challenges in accessing finance have been exacerbated due to Brexit. Lenders' appetite for investment has been impacted by the ongoing uncertainty.

4.133 The extent of development and capability within small processing companies can impact negatively on the ability of the sector to attract inward investment. Where processing companies have a low level of technological development or processing capability, stakeholders are concerned that companies are at risk of buy-out to secure supply for inward investors, with higher value-added activity shifted overseas rather than companies being developed and presented as attractive propositions for further development in the UK. This ultimately devalues the UK seafood processing sector, and constrains its competitiveness and ability to grow, to the benefit of overseas competitor markets.

Technology and innovation

4.134 Automation is being considered, and in some cases implemented, by seafood processors in response to the skills shortage and to improve efficiency, productivity and innovation. However, the research identified that this may be contingent on the skills supply issue being at least partly addressed in the short term: if businesses cannot quickly resolve the challenge of accessing an adequate workforce, businesses may have to downscale and so may not have the resources to invest in automation and new technologies. This would negatively impact on growth, and the sector's ability to grow in future.

4.135 An immediate impact would be that access to new technology would only be available to larger seafood processors. This would restrict the ability to grow through innovation to the larger processors in England and Scotland. However, a knock-on impact could be a shift to more wholesaling and distribution, and thus a reduction in primary processing. This would remove a considerable portion of the processing value chain from one part of the UK to another, or indeed from the UK altogether. Value-added activities would be undertaken elsewhere, reducing the UK's competitiveness. This is a significant risk to the sector in the UK, particularly for North East Scotland.

4.136 Businesses may think that the answer to the productivity and skills challenge facing seafood processing is to invest in new technology and automation. However, there is a strong view amongst stakeholders that investment at the present time will not generate sufficient returns to justify the capital outlay, given the small margins in the sector. Thus the seafood processing sector remains unable to fulfil its growth potential, and is at a disadvantage to countries such as Iceland[148], which has seen increasing levels of automation since the 1990s, and as a result, increases in productivity.

[148] For example, see: http://www.nordiclabourjournal.org/i-fokus/in-focus-2018/the-future-of-work/article.2018-05-14.2432920898

Political uncertainty and the impact of Brexit

4.137 Whilst not a market failure, Brexit presents some specific challenges to seafood processing in common with many other UK food processing and manufacturing operations, which are constraining growth in the sector. For example, whilst Northern Ireland processors are looking to grow value-added processing (historically, the majority of value-added activity on Northern Ireland produce has been carried out elsewhere, such as in France), there will be complications if there is no longer free movement of goods across borders. This will restrict growth opportunities in export markets that Northern Ireland is arguably more dependent on than perhaps elsewhere in the UK.

4.138 Brexit is likely to make the UK a 'third' country which means that there will be new certification regimes for shellfish and seafood products entering the EU market from the UK. This may add to the costs of exporting, as well as taking additional time to complete paperwork. Added to this, whilst some European ports may have seafood 'fast tracks', there is no guarantee that they all will. This is a risk to companies exporting fresh and frozen seafood produce, including live products, and will add to costs. All this will serve to restrict access to export markets that the UK currently has unfettered access to. Though there would be opportunities to explore alternative export markets, this would ultimately take time to establish; in the meantime, growth for the UK's seafood processing sector would be constrained.

Co-ordination failures and challenges

4.139 There are a number of challenges related to co-ordination failures in terms of seafood processing's relationship with other sectors, for instance commercial capture fishing. Stakeholders report that processors, especially in Scotland, often don't know what product will be available until the day of landing as fishing vessels provide no forward notice to processors (information asymmetry). Skippers are required to record catch data and so providing advance notice of catch should be possible in theory, but does not happen in practice. There is a perception that fishers believe that advance warning may negatively impact on price at market. This results in a lack of vertical integration in the fisheries-processing supply chain, particularly for white fish, which is not the case in competitor countries where fishers and processors are more aligned:

> "Compared to competitor countries like Iceland, vertical integration is the biggest point of difference…it allows Iceland to catch to order…rather than being supply driven."

4.140 This is a constraint for both fisheries and processing, with operations being less efficient than possible and limited scope for forward planning. As a result, growth opportunities are not being realised, and the sector (in conjunction with both fisheries and aquaculture) operates less efficiently than competitors – and so is less competitive.

4.141 A co-ordination failure that affects small processors in particular is that of understanding the end market. These processors tend to focus on primary processing, and are far removed from their markets. They often supply wholesalers rather than end buyers, which means they are less aware of their end markets and less able to respond to changes, which is a constraint to their development.

Community relationships, social licence and consumer preference

4.142 Seafood processors looking to expand or establish new facilities frequently encounter public opposition. This is usually on the grounds of impact on the public environment, and smell in particular. This is a clear constraint to growth and development. Addressing such issues are not straightforward, but they are important to maintaining or improving social licence.[149] This will need to be done with open engagement and evidence-based communication about how the issues are being addressed, and the intended outcomes. Seafood processing stakeholders in both Scotland and England reflected that this was a concern, and could impact on future growth of the industry.

4.143 A fundamental issue for growth of the sector in domestic markets is consumer preference, and how to bring about behaviour change in terms of what people in the UK eat. Over time, changes to eating habits in the UK have led to us consuming less seafood and a narrower variety than was the case historically. This had led to a situation described as:

> "…exporting what the UK catches, importing what the UK eats."

4.144 The phenomena contributes to the wider debate on the theoretical versus functional self-sufficiency in food production.

4.145 Allied to this there has been a decline in knowledge and confidence in preparing and cooking seafood amongst UK households. This is a significant challenge in exploiting domestic markets, bringing new products to market and addressing the balance between exports and domestic consumption, which may be important if Brexit causes a decline in exporting to the EU.

4.146 Bringing about a change in consumer eating and cooking habits is a long-term project. As well as increasing consumption, it could broaden the range of species that we consume, including to under-utilised species and types of fish historically (but no longer) consumed in the UK, such as cuttlefish. To have any real impact and fuel growth, there would need to be substantial and sustained effort to bring about change in preference amongst a sizeable proportion of the UK's population. This is a potentially significant growth market if consumer preference can be influenced; however, the required education and marketing would not be undertaken by a single seafood processing (or indeed fishing) business, as the whole of the sector would

[149] Social licence, or social licence to operate, is the ongoing acceptance of a company or industry's standard business practices and operating procedures by its employees, stakeholders, and the general public.

stand to benefit – i.e. a potential market failure due to spill-over effects (positive externality). Effective co-ordination would therefore be required. As an example of this, the Shellfish Association of Great Britain is undertaking work through Billingsgate Seafood School, as well as a programme of primary education engagement to encourage greater levels of seafood cooking and consumption at home. They are also delivering an EMFF-supported business-to-business project aimed at encouraging more restaurant and hospitality businesses to use seafood, and there is public promotion around this.

Commercial seaweed harvesting

Sector overview

4.147 The commercial cultivation and harvesting of seaweed has attracted increased attention in recent years, boosted by the publication of advisory notes regarding seaweed cultivation. There is enormous growth potential but the sector currently remains small-scale in the UK. There are some well-established, hand-harvesting operations, such as in South Wales, and also the Western Isles of Scotland and parts of the West coast of Scotland for food products such as Laverbread and 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.[150]

4.148 Stakeholders across the UK recognise that seaweed is a very valuable resource that is not currently being exploited. However with some sites now licenced to cultivate, this may change. Nevertheless the small base brings a number of challenges around scaling up the industry on a sustainable basis. These are dealt with in turn below.

[150] For example, Marine Biopolymer Ltd., based in Ayrshire

Figure 3.4: At-a-glance assessment of sector constraints for commercial seaweed harvesting

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	-	- -	- -	- -	-	- -	-
England	-	- -	- -	- -	-	- -	-
Northern Ireland	-	- -	- -	- -	-	- -	-
Scotland	-	- -	- -	- -	-	- -	- -
Wales	-	- -	- -	- -	-	- -	-

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Human resource and access to labour and skills

4.149 As may be expected in a nascent sector, a sustainable skills supply is a challenge and a constraint to growth. There is a shortage of the technical and operational expertise required to develop the sector. This is a constraint on the sector in terms of access to the necessary expertise for development and growth. However, this is a fast evolving area: the Scottish Association for Marine Science UHI is a global hub for research capabilities in marine biotechnology.[151] Swansea University in Wales[152], the University of Exeter and Plymouth Marine Laboratory[153] in England and Queen's University Belfast[154] in Northern Ireland all have expertise in seaweed research. Therefore this appears to be a short-term constraint, with industry-focused institutes developing the necessary scientific skills to underpin R&D and innovation to support the industry. However, a longer term consideration may be in providing skills and labour for operational roles and in developing supply chains and new markets, as the industry develops and grows.

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

[152] https://www.swansea.ac.uk/bioscience/research-and-impact/algal/

[153] http://www.exeter.ac.uk/news/featurednews/title_714511_en.html

[154] https://www.qub.ac.uk/research-centres/QueensUniversityMarineLaboratory/research/SeaweedResearch/

Environment and natural resources

4.150 The seasonality of algal biomass acts as a constraint, and does not guarantee a constant or predictable supply of seaweed. This potential variation in yields may have an undue effect on seaweed prices, the reliability of which would be an influencing factor for market entrants and start-ups.

4.151 Whilst existing small-scale cultivation is considered low risk, large-scale cultivation is facing challenges due to concerns from policymakers and others about environmental risks. This is due to the potential for a market failure to arise through rapid growth of the industry. Such a situation could result in environmental degradation and depletion of natural resources.

4.152 There is uncertainty on the extent to which commercial seaweed harvesting may impact on the marine environment and other marine uses. However, existing research suggests that the impacts may be significant, and any commercial activity should be closely monitored to address uncertainty, fill gaps in knowledge surrounding commercial seaweed harvesting, and facilitate informed decision-making.[155]

4.153 In the absence of data and evidence, stakeholders and policy makers have acted to mitigate against potential negative externalities. A number of legislative mechanisms, such as Scotland's Crown Estate Act 2019, Environment (Wales) Act 2016 and others seek to safeguard against unsustainable commercial harvesting. The Scottish Government is currently conducting a review to gather evidence to help ensure existing seaweed harvesting activity and future proposals are sustainable, in order to ensure that Scotland's marine environment is protected.[156] Decisions and policy should be based on sound data to balance harnessing the potential benefits, but sustainably.

Financial capital

4.154 Two key financial challenges exist for 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. In many senses, it is an unknown quantity to banks and commercial lenders, and so is deemed as an investment risk, even more so than aquaculture or commercial capture fishing. This is compounded by the seasonality of algal biomass, as discussed above. 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.

[155] Campbell, I. et al. (2019) the environmental risks associated with the development of seaweed farming in Europe – prioritising key knowledge gaps, Frontiers in Marine Science, Volume 6 Article 107, pp.1-22

[156] https://www2.gov.scot/Topics/marine/seamanagement/seaweedrev

4.155 Secondly, seaweed harvesting itself is not necessarily high value, but the downstream value chain can be very high value, for example pharmaceuticals and other marine biotechnology applications. As identified in consultation with stakeholders, there is an information failure here, in that the downstream industrial and commercial applications of seaweed are not taken into consideration by investors.

Technology and innovation

4.156 A key constraint to the development of the commercial seaweed harvesting industry identified through this study is a lack of knowledge exchange and research alignment between academia and industry. Whilst some industry actors are progressing with industrial research on the feasibility of seaweed harvesting on a commercial basis, higher education and research institutions are undertaking a considerable range of scientific research. However, there is a perception that this research is not immediately accessible to industry. There is a need to overcome this information failure 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. 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, for example. This is a particular concern in Scotland.

Social licence constraints

4.157 Commercial seaweed harvesting has been subject to perceptions of scale: small-scale harvesting being associated with local and 'natural' products, whereas recent efforts to develop large scale seaweed harvesting[157] have faced strong opposition, based on sustainability concerns. These challenges are not unlike those faced by aquaculture operations. Without addressing these sustainability concerns, seaweed harvesting will undoubtedly be constrained by a lack of social licence to operate, and negative impacts arising from how the industry is viewed.

Offshore renewables

Sector overview

4.158 Whilst offshore wind is a comparatively mature sub-sector, other components of the offshore renewables sector are nascent. Though there have been some recent success stories in terms of deployment, the growth of wave and tidal energy in the UK is uncertain. There are a range of factors impacting on the growth potential of offshore renewables, and these are set out in the sections below.

[157] http://www.scotlink.org/wp/files/documents/SE_LINK_Response_Marine-Biopolymers-Scoping-Report_2018.pdf

Figure 3.5: At-a-glance assessment of sector constraints for offshore renewables

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	-	-	-	- -	- -	- -	-
England	-	-	-	-	- -	-	-
Northern Ireland	-	-	-	- -	- -	- -	-
Scotland	-	- -	-	- -	- -	- -	-
Wales	-	-	-	- -	- -	- -	-

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Human resource and access to labour and skills

4.159 Wave and tidal energy is an emerging sector and there is not yet any evidence-based clear understanding of what skills are required over and above the need for STEM skills across the energy sector and wider economy. Due to its early stage, there is of course a requirement for the skills to carry out research and development, including testing of new technologies.

4.160 Offshore wind, is relatively mature but skills supply is still perceived to be an issue by stakeholders and employers in the sector, and was a key finding in the research. Evidence indicates that there is a high proportion of hard-to-fill vacancies amongst offshore wind development, operation and supply chain employers.[158] This is despite there being a high degree of skills in the sector that are transferable with/from other sectors, such as marine engineering, diving, and oil & gas.

4.161 Whilst information on skills gaps is lacking, there is an identified market failure in the UK in terms of domestic access to the engineering skills to build components for offshore renewables. An information asymmetry also exists here, in the time lag between current training versus likely future demand for skills. Further, people choosing particular education routes do not know of opportunities that may arise within an expanding industry. There is also a mismatch between the region of the UK in which there is technology and engineering expertise and where there is offshore wind and offshore wind installations. For example, Northern Ireland has a wide range of engineering, aeronautical and materials expertise as a result of its aerospace industry. These are valuable skills for offshore wind, but there are few offshore wind installations in close proximity to Northern Ireland, as seas are much

[158] UKCES (2015) Reviewing the requirement for high level STEM skills

deeper around Northern Ireland's coast and so require different and more expensive technology.

4.162 The impact of this skills market failure is that many of the higher value jobs and activities currently take place outside of the UK and so the value is not captured in our economy.

Environment and natural resources

4.163 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 energy and growth. Around 50% of Europe's wave energy, and 35% of Europe's tidal energy is in UK waters. The UK Government estimates that wave and tidal energy has the potential to meet up to 20% of the UK's current electricity demand – an installed capacity of 30-50 GW.[159] However in reality, tidal is more developed than wave with industry and strategic stakeholders reporting that wave energy may be at least 10 years behind tidal in terms of progress towards commercial viability.

4.164 The Offshore Renewable Energy Catapult and the Offshore Renewable Energy Science and Innovation Audit[160] have identified a range of opportunities, focused on increasing installed generation capacity to take advantage of this significant resource to create cleaner, secure energy systems. There are a range of installations around the UK, including around the Pembrokeshire coast and Anglesey in Wales to take advantage of its favourable tidal conditions, Wave Hub off the North coast of Cornwall, and Strangford Lough in Northern Ireland. However, it is no surprise, given its coastline that Scotland has access to the greatest share of potential marine (wave and tidal) energy resources, and has consented and deployed more wave and tidal energy devices than anywhere else in the UK. Through EMEC[161] on Orkney, there have been more wave and tidal devices deployed than in any other single location in the world.

4.165 However, there is a major challenge here in harnessing this natural resource. The strength and power and force of waves and tidal currents in the UK's territorial waters – particularly around Scotland – has proved a significant limiting factor in the development of marine energy generation, and for wave energy in particular. There have been some high profile failures[162] in test devices for wave energy due to the force generated by waves at test sites, although this is to be expected in emerging technologies which are inevitably risky.

[159] RenewableUK (2017) Ocean Energy Race: The UK's Inside Track

[160] https://www.ncl.ac.uk/media/wwwnclacuk/business/files/sia-report-offshore-energy.pdf

[161] http://www.emec.org.uk/

[162] e.g. Gray, A. et al. (2017) Reliability and O&M sensitivity analysis as a consequence of site specific characteristics for wave energy converters, Ocean *Engineering*, 141, pp.493-511; at: https://doi.org/10.1016/j.oceaneng.2017.06.043

4.166 Marine energy can often conflict with other marine uses, such as fishing or marine tourism, through competition for space. However, there is some scope for co-location and there is emerging thinking about the potential for this, as identified in the research. As well as providing power[163] (or simply new locations[164]) for aquaculture production sites, it is possible that marine energy installations – and specifically offshore wind farms – can provide opportunity to regenerate fisheries, by creating 'protected zones' that are out of scope for fisheries.[165]

Infrastructure for offshore renewables

4.167 A critical constraint is that the current national grid configuration is not suited to capture energy generated from more dispersed, decentralised energy sources, such as marine renewable energy. The remoteness of many sites for wave and tidal energy generation, means that they are not currently connected to the national grid. For example, Shetland has significant potential for both tidal and wave energy developments but there is no connector to the UK National Grid.[166] There is a technological gap that requires R&D into cost-effective solutions for power transmission. Currently, individual generators bear the risk, whilst many stand to benefit from any gains.

4.168 This lack of route to market is a clear market failure. It means that we can generate large quantities of clean, renewable energy but lack the infrastructure to allow it to be used to meet the demand for energy effectively meaning there is a barrier for supply to reach demand. This means that it is not having the impact it could have on meeting environmental targets and also, that the sector's growth is constrained as it cannot get its 'produce' to market. If this is not resolved, the UK offshore renewables sector may lose its position as a global leader and see a declining market share.

Financial support

4.169 Financing and accessing investment is a challenge for organisations operating in the marine renewable energy sector, not least because the sums are substantial. The cost per installed MW of offshore wind is high although reducing. However, wave and tidal energy development remain high cost because they are in the early stages of technology development. Because of this and the inherent risk, investors are reluctant to enter the market. Government intervention mechanisms such as the Scottish Government's Energy Investment Fund (EIF, which superseded earlier mechanisms such as the Renewable Energy Investment fund (REIF))[167] seek to

[163] http://www.sarf.org.uk/cms-assets/documents/152961-230407.sarf093.pdf

[164] https://www.seafish.org/media/Publications/10517_Seafish_aquaculture_windfarms.pdf

[165] https://www.westofmorecambe.com/co-existence/

[166] Neill, S.P. et al. (2017) The wave and tidal resource of Scotland, *Renewable Energy*, 144(A), pp.3-17; at: https://doi.org/10.1016/j.renene.2017.03.027

[167] https://www.scottish-enterprise.com/support-for-businesses/funding-and-grants/accessing-finance-and-attracting-investment/energy-investment-fund

encourage greater levels of investment by acting as junior lenders to attract private sector investment, and offset commercialisation costs.

4.170 Previous studies estimating the future contribution of the UK's energy generation were predicated on there being a Renewable Obligation that would be paid to the generators, or that wave and tidal would be ring-fenced within Contracts for Difference (CfD).[168] Recent rounds of the CfD auctions haven't supported offshore renewables, making the route to market for wave and tidal energy in the UK very challenging, because of the inherent risks to renewables generators, as above in paragraph 3.167. These market incentives are essential to address the evident market failure, that the technology being used is new and comparatively unproven, and so cannot be competitive in current energy markets. The support route is primarily CfD, but this currently has no ring fenced provision for wave and tidal energy. Adequate support mechanisms are needed so the technology can break into the marketplace.

4.171 This issue has been compounded by competition from offshore wind, a much more mature technology which has been supported by government and industry to scale up, and as a result, is currently more competitively priced.

4.172 These factors have inhibited the development of wave and tidal energy and its progress to market. As identified through the research, there is broad agreement that some tidal and most wave technology is not yet ready for deployment without CfD support. Welsh stakeholders reported that some technologies are considered to still be too risky for the Welsh Government to support without the security provided by CfD.

4.173 A further challenge facing the UK offshore renewable market is that investment and subsidy for wave and tidal energy in the UK remains limited, with the result is that commercial investors are more attracted to investments in other marine energy markets such as the Far East, for example tidal barrage operations in South Korea. The danger for the UK economy is that we lose competitive advantage in global markets, as well as lose ground in terms of developing and owning the technology.

Technology and innovation

4.174 As highlighted in the MAXiMAR Marine Economy Science and Innovation Audit[169] and other studies, wave and tidal technologies, as well as floating offshore wind, are all still at a relatively early stage. Investment is required to share the risk and demonstrate feasibility and market readiness, or in the case of wave energy, work towards it. This is demonstrated by the number of current and recent investment and support mechanisms targeting marine renewable energy, and wave and tidal in particular. The Atlantis/MeyGen development in the Pentland Firth is a

[168] e.g. previous ORE Catapult estimates

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

good example of a success story of public sector investment from Scottish Investment Bank through the Renewable Energy Investment Fund (the predecessor to the Energy Investment Fund), the Crown Estate, Highlands and Islands Enterprise, and the then UK Government's Department of Energy and Climate Change (DECC; merged with Department for Business, Energy and Industrial Strategy (BEIS) in July 2016). The investment ensured commercial viability of the project and attracted private sector investment through Equitix.

Political challenges

4.175 There is a perception amongst stakeholders, particularly outside of England, that the political interest in wave and tidal energy varies across the UK. There is a strong sense that some devolved administrations are much more engaged with it whilst the UK Government is perceived to give it less priority and place less value on the potential for wave and tidal energy. As one stakeholder noted:

> "There is a challenge regarding conflicting responsibility on devolved and reserved matters, where there needs to be much more alignment."

4.176 There is a concern that if the UK Government does not fully recognise and support its potential, the development of wave and tidal energy in the UK will be constrained. This means that it will not become a viable UK energy source that can access the enormous opportunities presented by the renewables energy market. The lack of ring-fenced provision for wave and tidal in successive rounds of CfD auctions, which are run from Westminster, is offered by stakeholders as a material demonstration of the variable interest and level of priority in different parts of the UK. The perceived disconnect between UK Government interest and the potential of the sector may impact on future growth, and the ability of offshore renewables to fully exploit opportunities.

4.177 It was also noted through the research that many of the challenges facing the offshore renewables sector are compounded in Northern Ireland by the existence of a single energy market on the island of Ireland.

Community relationships and social licence

4.178 Public perception around off-shore windfarms can be a challenge: the presence of large windfarms along the coastline is not always viewed positively and can meet substantial opposition for example through groups such as The Save Our Scenery Campaign in Wales and Scotland Against Spin. The main objections are centred on aesthetics, with a body of opinion objecting to off-shore wind farms on the basis that they are an 'eyesore', and also that the construction of off-shore wind turbines and wave and tidal devices can be disruptive to the marine environment and sea life. In the research some stakeholders raised concerns about the impact of marine energy devices on marine life. The impact of offshore wind devices on birds is well-documented, but there may be similar issues with aquatic wildlife. Similar concerns were raised about piling for offshore wind turbine foundations, and anchor cables for tidal turbines. Countering this, there is evidence to suggest that mollusc

and fish populations have risen as the turbines act as an artificial reef.[170] It may be possible to site windfarms further out to sea in future, but technology is more complex and currently expensive, and the construction and maintenance would be more difficult and costly.

4.179 If this opposition means that offshore renewables energy devices, be they tidal, wind or wave, are not deployed, then the growth of the sector will be constrained.

Oil & gas decommissioning

Sector overview

4.180 A key challenge around oil & gas decommissioning is the degree of uncertainty that exists regarding the scale of opportunity. Previous estimates placed a ten-year expenditure for decommissioning at £17.6bn[171] on the UK Continental Shelf (UKCS) but this was recently updated to £15.3bn over the next decade.[172] 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.

[170] For example, see: https://www.technologyreview.com/s/608930/first-evidence-that-offshore-wind-farms-are-changing-the-oceans/

[171] HIE/SE (2016) Oil & Gas Decommissioning Action Plan

[172] Oil & Gas UK (2018) Decommissioning Insight 2018

Figure 3.6: At-a-glance assessment of sector constraints for oil & gas decommissioning

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	-	- -	-	+	+	-	- -
England	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Northern Ireland	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scotland	-	- -	-	+	+	-	- -
Wales	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Human resource and access to labour and skills

4.181 The UK is emerging as a global leader in offshore decommissioning, with strengths in the technical and commercial aspects of decommissioning. Its competitive advantage is due to expertise in the North Sea. Nevertheless, there is perceived to be a lack of experience and knowledge exchange (particularly in project management), which presents a challenge. There have been few large-scale decommissioning projects or sustained periods of activity to date. Evidence through the research has identified that 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. 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 so benefiting the UK more widely. It also impacts on the ability to export these skills to overseas markets, and thus secure more gains from the UK's oil & gas decommissioning expertise.

Environment and natural resources

4.182 As the oil & gas decommissioning industry develops, there is a debate regarding full decommissioning of infrastructure versus leaving at least some installations in situ. Removal of platforms, well-plugging and abandonment carry a risk of pollution; equally leaving platforms in place may also have some environmental consequences. [173] However, allowing infrastructure to remain can

[173] https://www.theguardian.com/business/2019/sep/04/uk-facing-eu-outrage-over-timebomb-of-north-sea-oil-rigs

create natural reefs, and actually allow sea life to flourish. How the sector develops will influence public opinion on oil & gas decommissioning. There is an environmental lobby arguing the case for a "rigs to reef" approach.[174] Whilst this may ultimately represent a loss or only partial realisation of economic opportunity presented by decommissioning, it could serve to strengthen the UK's marine environmental resource. 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 layout required. Though there is much activity supported by both industry, academia and the public sector – such as the Oil & Gas Technology Centre and Oil & Gas Innovation Centre, both based in Aberdeen – this is an areas that is likely to require ongoing support to bring further innovations to market.

Infrastructure requirements for oil & gas decommissioning

4.183 The majority of decommissioning activity in the UK is expected to take place in Scotland. Although onshore recycling and disposal is a relatively mature sector with established supply chains, stakeholders identified that there is a lack of suitable port and supporting infrastructure capable of handling an increase in decommissioning activity, and larger decommissioned infrastructure. There is also a lack of on-shore laydown areas and hazardous waste capability. This market failure in infrastructure provision means that the UK is unable to take advantage of larger decommissioning project opportunities. Some Scottish ports are currently expanding and developing their deep water facilities in response, or have expansion plans.[175,176]

4.184 Decommissioning activity must be supported by accessible recycling facilities for the materials generated by decommissioning. Port development must consider this if it is not to act as a constraint to growth. Decommissioning and infrastructure recycling facilities are often not immediately located near ports, thus increasing transportation times and costs. There is a natural monopoly here in that it isn't cost effective for all ports to have recycling facilities; therefore it is more advantageous to have strategic hubs and ensure their not charging monopoly prices. However, access to these hubs needs to be better enabled.

Political challenges facing decommissioning

4.185 Overseas competition is a significant challenge for UK oil & gas decommissioning. Globally it is recognised as a sector with enormous potential and many international facilities and operators are supported or financed by national governments. They offer a lower cost option to oil & gas exploration and decommissioning companies, putting UK operations at a distinct market disadvantage.

[174] https://scottishwildlifetrust.org.uk/our-work/our-projects/living-seas/decommissioning/

[175] HIE/SE (2016) Oil & Gas Decommissioning Action Plan

[176] http://news.hie.co.uk/all-news/scottish-energy-ports-capability-directory-is-launched/

Marine tourism

Sector overview

4.186 Tourism is a very important sector in many parts of the UK and makes an important contribution to the economy, perhaps most significantly in more rural and isolated areas such as Cornwall, the Highlands of Scotland, West Wales, and in rural parts of Northern Ireland. Marine tourism is a growing sector but faces a number of potential constraints.

4.187 The volume of visitors across the breadth of marine tourism activities and opportunities can have a negative impact on coastal communities and the marine environment of the UK. High visitor numbers, and the types of marine tourism activity, can place stress on physical resources as well as the amenities, services and facilities in the areas and the communities that support marine tourism.

4.188 The structural challenges and constraints facing marine tourism across the UK are explored below.

Figure 3.7: At-a-glance assessment of sector constraints for marine tourism

	Human/skills	Environmental/ Natural	Infrastructure	Financial	Technological	Political/co-ordination	Community/ social
UK	-	- -	- -	+	N/A	-	- -
England	-	- -	- -	+	N/A	-	- -
Northern Ireland	-	- -	- -	+	N/A	-	- -
Scotland	-	- -	- -	+	N/A	-	- -
Wales	-	- -	- -	+	N/A	-	- -

Key	+	No challenge, or addressed through existing activity	-	Minor challenge impacting somewhat on growth	- -	Major impact or market failure with impact on growth	- - -	Major market failure with significantly constraining sector growth

Main challenges and constraints

Human resource and access to labour and skills

4.189 Marine tourism is a key source of employment and self-employment for many coastal communities. It provides jobs and income in areas where there are limited opportunities. However employment in marine tourism, whether in retail and

hospitality or in other tourism-related sectors, is often low-skilled, low-paid and seasonal, with little or no career progression.[177]

4.190 Nevertheless, low pay and lack of career opportunities in this and other sectors in remote, rural coastal communities is a major driver for out-migration, particularly of young people. This constrains the sector's access to labour. Research recently undertaken by ekosgen[178] has demonstrated the extent to which a lack of employment and career opportunities is a major factor in causing young people to leave the Highlands and Islands of Scotland, many areas of which are fragile coastal communities. This is a pattern that is repeated across many rural and coastal areas of the UK.

Environment and natural resources

4.191 The research with key informants identified that marine tourism remains under-developed, with a number of stakeholders considering that it was currently a "missed opportunity". There is a market failure arising from a positive externality, in that the environment and infrastructure are public goods that are free to access, and so tourists enjoying it don't always pay. As a result, there is an underinvestment in the marine environment's natural capital compared to what is required to achieve the social optimum.

4.192 Many stakeholders pointed to the respective offers in each country, whether this was sailing in Scotland, wildlife tourism in Wales, heritage coastal tourism in Northern Ireland or marine sports in England. Northern Ireland is considered to be particularly under-developed, as tourism has only really emerged as a strong sector overall in the last decade. There is a lag relative to the rest of the UK as a result of the Troubles, but there has been a recent shift driven by the popularity of Game of Thrones and other TV programmes and movies filmed in Northern Ireland.

4.193 There was a consensus that there is no detailed understanding of the current and potential economic value of marine tourism to the UK: the market failure here is that marine tourism actors are operating with imperfect information. Consultees acknowledged that a key part of the challenge here is a lack of consistent and robust data on either socio-economic aspects of marine tourism, or indeed on environmental aspects. This is needed to better plan and manage tourism, particularly where over-tourism is a potential challenge, so that the visitor experience and the environment as the driver of tourism is not diminished. Without this, responsible bodies are reluctant to permit marine tourism activity, or businesses risk operating in an unsustainable manner.

4.194 It was widely acknowledged that marine tourism should not detract from the environmental value of the UK's coasts and marine environment. Many stakeholders

[177] For example, see: UKCES (2012) Sector Skills Insights: Tourism; Cebr (2014) Understanding the travel and tourism labour market: A report for ABTA

[178] ekosgen for HIE (2018) Young people in the Highlands and Islands: Maximising Opportunities; see also ekosgen for HIE (2015) Young People in the Highlands and Islands: Attitudes and Aspirations

identify that a high volume of tourism, and the consequent pressures can have an adverse impact on the marine environment. Stakeholders in Wales perceive this to be a particular challenge, with a significant proportion of Wales's coastline having protected status. Marine users may be unaware of the environmental sensitivities of many marine leisure activities, and there was an identified need for higher levels of education amongst visitors and marine users.

Infrastructure challenges and dependencies

4.195 The infrastructure in coastal destinations in the UK often present two inter-related structural challenges.

4.196 On the one hand, the rural and remote nature of many marine tourism destinations means that they can be relatively distant from their markets, and attracting visitors is a challenge as is actually getting them there because transport links and roads are inadequate. This is a very specific market failure that arises from the geography of coastal areas, and the relative immobility of tourists to these areas compared to other destinations.

4.197 Conversely, these areas often have a lack of necessary infrastructure to adequately support tourism, across coastal and on-shore areas and the immediate hinterland. This is a structural challenge that manifests itself in terms of inequality of resources, services provision, investment, etc. in remote coastal areas. This can lead to degradation of infrastructure such as footpaths, car parks, etc. as well as unsustainable demand on services and utilities.

4.198 In some cases, where geographical barriers to visitors can be overcome, there may be negative impacts on the attractions themselves arising from the volume of visitors. This has been reported in Orkney on sites such as the Ring of Brodgar, Skara Brae and Maes Howe, arising from an increase in volume tourism from cruise ships.[179] Additionally, the infrequent or irregular pattern of high volumes of tourism – e.g. from cruise ships, a particular challenge faced by coastal communities such as Portree and Kirkwall – mean that businesses may face challenges in accommodating short-term spikes in visitor numbers. This may also cause tensions with local communities.

4.199 Often, there is a silo approach to tourism development, in isolation from non-tourism matters such as infrastructure that serve to make tourism a success in many destinations. This often constrains development of marine tourism destinations, with public and private stakeholders not working together effectively to ensure development that meets the needs of marine tourism and the communities that support it (a co-ordination failure). There is a need for a holistic and integrated approach to such matters, with local authorities, transport authorities, community development trusts and business organisations more actively involved in tourism destination development, and tourism bodies and destination management

[179] ekosgen/Reference Economics for HIE (2017) *Orkney Volume Tourism Management Study*

organisations (DMOs) involved to a greater degree in strategic, non-tourism matters of service and infrastructure provision.[180]

4.200 One potential solution to ensuring adequate infrastructure is the implementation of a transient visitor levy, or tourism tax. This is being given some consideration in some destinations in the UK as a means to generate revenue to invest in and maintain infrastructure.

Political challenges

4.201 Internal (UK domestic) competition for visitors is a particular challenge for the sustainable growth of marine tourism in the UK. From an international perspective, visitors are attracted to the UK, or to countries within the UK in the first instance; it is arguable that there is then a degree of competition between destinations within the UK for those visitors.

4.202 Stakeholders identified that this may raise an issue of parity in area-based approaches to development, or in the support provided to destinations for their development. Consequently, there is a danger that a degree of displacement may occur, prompting questions about the true extent of any additionality of public sector support for marine tourism.

4.203 At a more transitory level, Brexit appears to be having an impact on marine tourism, and tourism more generally. Evidence identified through the research, along with other evidence and data, suggests that overnight visitor numbers and spend are down between 2017 and 2018.[181] Additionally, some industry stakeholders reported that the number of sailing vessels in Scottish waters has dropped recently. It was reported through consultations that this was in part due to exchange rates and the drop in the value of the Pound, meaning that vessels were being bought and moved to other areas, e.g. Scandinavia.

[180] ekosgen for HIE (2019) Review of support to tourism destinations

[181] Great Britain Tourism Survey and International Passenger Survey data

5 Overview of existing support mechanisms

Introduction

5.1 This chapter provides an overview of the main support mechanisms currently available to organisations and institutions operating within the UK's marine sectors, considering financial and technical support. It first sets out the key mechanisms available, the level they are available at and their key priorities. Following this, the chapter then considers any areas not covered by existing support, and any factors hindering the availability or access to these support mechanisms.

5.2 In order to provide a concise and clear overview, this chapter focuses on the key aspects of the interventions available. However, a more extensive list of support mechanisms has been compiled and can be found at Appendix 3, available as a Supporting Document.

Coverage of financial and other support mechanisms

5.3 A wide variety of support is available to the UK's marine sector. The majority of this support is delivered through financial mechanisms, such as funding for sustainable economic development projects, funding to support projects aimed at enhancing biodiversity and the natural environment, and funding to support and drive research and collaboration. Other support mechanisms include networking centres, marine research programmes and industry promotion and representation bodies.

European support mechanisms

5.4 A number of support sources are available at European Union level. Arguably the most significant of these is the European Maritime and Fisheries Fund (EMFF)[182], which provides support for sustainable development within the fishing and aquaculture sectors, as well as supporting conservation of the marine environment, alongside growth and jobs in coastal communities in the UK. The Marine Management Organisation (MMO), Marine Scotland, the Department of Agriculture, Environment and Rural Affairs (DAERA) and the Welsh Government act as the Managing Authorities for the EMFF in each country of the UK, with around £190m split between each country over the period 2014 to 2020. The EMFF provides funding for investments in areas such as: on board fishing vessels, gear replacements, improvements to shore-based facilities, advisory services, partnerships, training and innovation, fisheries management and seafood processing, and aquaculture, animal health and inland fishing.

5.5 The LIFE programme[183] is also available at EU level, replacing the previous LIFE+ programme. The LIFE programme offers financial support for nature and biodiversity projects in line with EU directives on the birds, habitats and biodiversity

[182] https://www.gov.uk/guidance/european-maritime-and-fisheries-fund-emff-before-you-apply
[183] https://ec.europa.eu/easme/en/life

strategy 2020. Notably, it covers marine and coastal management as part of funding for environment and resource efficiency projects. The current funding period is from 2014-2020 with a total budget of €3.4bn at the EU level. A 2017 project, RELIONMED-LIFE, in which the University of Plymouth is a delivery partner, aims to prevent the invasive Lionfish species disrupting ecosystems. A project delivered through LIFE+ and completed in 2016, BLUETEC aimed to demonstrate the technical feasibility and cost effectiveness of a full-scale 1 MW tidal-energy installation. The Environmental Research Institute at North Highland College UHI was a delivery partner.

5.6 Other EU-level support mechanisms include Funding FISH[184], an international funders collaborative developed with sole intention to support the implementation of the Common Fisheries Policy to drive sustainable fisheries. Support takes the form of grant-making and, additionally, Funding FISH works with potential partners to identify match funding and project development.

5.7 Horizon 2020[185] is the EU's framework programme for research and innovation, providing around €80bn of funding between 2014 and 2020 for research projects to develop and demonstrate innovative technologies and approaches in response to major societal challenges such as climate change or food security. For example, a funding call for a 2018-19 project on Wave Energy Research & Development sought to consider the design, development and validation of cost-effective wave energy converters able to survive in a harsh and unpredictable ocean environment.

5.8 Many of the EU's territorial co-operation (Interreg) programmes focus on marine and maritime issues. For example, the Ireland-Wales Territorial Cooperation Programme 2014-2020[186] is a maritime-focused programme connecting organisations on the west coast of Wales with the south-east coast of Ireland. It focuses on seeking solutions to shared challenges and improvements to the economic and sustainable development priority of Wales and Ireland, targeting cross-border innovation and the adaptation of the Irish Sea and coastal communities to climate change. Likewise, the 2 Seas Programme targets issues relating to economic, social and environmental sustainability on the coastal areas of South East England and East Anglia, as well as in France, Belgium and the Netherlands. Funded projects through Interreg programmes include Bluefish[187], which aims to develop knowledge and understanding of the marine resources of the Irish Sea and Celtic Seas by addressing knowledge gaps regarding the effects on and potential vulnerability of selected commercial fish and shellfish from predicted climate change. The Sustainable and Resilient Coastal Cities (SARCC) project seeks to address the

[184] https://fundingfish.eu/

[185] https://ec.europa.eu/programmes/horizon2020/

[186] https://irelandwales.eu/

[187] http://bluefishproject.com/

challenge of rising sea levels by helping to mainstream nature-based solutions (NBS) into coastal management and policy making.[188]

UK-level and national/devolved administration support mechanisms

5.9 A wide range of support is available at UK level, ranging from financial interventions to research/advisory support.

5.10 The UK Government introduced the Coastal Communities Fund (CCF)[189] in 2012 to support economic development projects in coastal regions throughout the UK. The CCF aims to do this through the promotion of sustainable economic growth and jobs. The UK Government announced in 2015 that the CCF was to be extended to 2020/21 with at least £90m of new funding available across the UK from the period 2017/18 to 2020/21. Round 5 funding amounts to £40m to be allocated between April 2019 and March 2021. Since the start of the CCF, grants have been awarded to 295 projects across Scotland, England, Wales and Northern Ireland to a value of £174m – these projects are forecast to deliver 18,000 direct and indirect jobs, and help attract over £316m of additional funds to coastal areas.[190]

5.11 Seafish is a Non-Departmental Public Body (NDPB)[191] set up by the Fisheries Act in 1981 and is funded by a levy on the first sale of seafood products in the UK, including imported seafood, in accordance with the 1982 Fisheries Act. Seafish offers information, support and guidance on careers and training in the seafood industry, as well as providing research and data on a range of marine topics and promoting seafood throughout the UK. EMFF/MCA funding is available for training through Seafish.

5.12 The Centre for Environment, Fisheries and Aquaculture Sciences (Cefas)[192] is an executive agency sponsored by the Department for Environment, Food & Rural Affairs and offers research and advisory support to the UK marine sector through collection, management and interpretation of data on the aquatic environment, biodiversity and fisheries. Similar support is provided by the National Oceanography Centre[193], which undertakes research in large scale oceanography and ocean measurement technology innovation, working with businesses of all sizes on the creation and advancement of new technologies (these are funded by Innovate UK).

5.13 Contracts for Difference (CfD) replaced the Renewables Obligations in the UK following the Energy Act (2013) receiving Royal Assent. By fixing the prices received by low carbon generation, this reduces risk for renewable energy generators and encourages greater levels of investment. Whilst industry stakeholders had previously anticipated specific provision for wave and tidal energy in CfD auctions, the most

[188] https://www.interreg2seas.eu/en/sustainable-and-resilient-coastal-cities
[189] https://www.gov.uk/government/collections/coastal-communities
[190] https://publications.parliament.uk/pa/ld201719/ldselect/ldseaside/320/32009.htm
[191] https://www.seafish.org/
[192] https://www.cefas.co.uk
[193] https://www.noc.ac.uk/about-us

recent round did not include any, so CfDs continue to largely benefit offshore wind in terms of marine energy. Future CfD auctions may still offer potential for the sector, and particularly tidal, if they can be adjusted to fairly accommodate emerging technologies. Marine energy projects using emerging technologies need a mix of tapered support mechanisms, of which CfD is just one. Beyond the capital support requirement for initial R&D, CfD could remove some of the challenges the wave and tidal technologies face in terms of routes to market during the generation phase. At present, wave and tidal energy needs support in this regard, and addressing shortcomings around CfD auctions is one way of achieving this.

5.14 At the national level and lower (i.e. devolved administrations and local authorities), a wide range of financial, research, networking and business support is on offer to the UK marine sector. A number of Funds are available in Scotland, including the recently relaunched Saltire Tidal Energy Challenge Fund[194], which has a principal aim of driving innovation and incentivising investment in the Scottish tidal energy sector, supporting a pathway to long term cost reduction. A total of £10m is available for projects related to the development of a material/technical innovation aimed at reducing the levelised cost of energy (LCOE) from tidal generation.

5.15 The Scottish Aquaculture Innovation Centre (SAIC)[195], one of eight innovation centres introduced by the Scottish Government to drive growth, connects industry with academia to encourage collaboration on priority issues as well as share insights and knowledge and attract addition UK and EU investment into Scottish aquaculture. Funding is available to a company active within Scottish aquaculture that is willing to contribute resources to the project. In collaboration with an industry partner, any recognised Scottish higher education institution can also apply. Projects should target: environmental and health challenges, particularly around sea lice and gill health; feed development optimising fish health and nutrition; unlocking capacity for aquaculture development through innovative, evidence-based approaches; or establishing a reliable supply of mollusc spat.

5.16 Examples of more local support mechanisms include the proposed development of an Aquaculture Hub for Innovation[196] as part of the Stirling and Clackmannanshire City Region Deal, which would see a centre for research and development opportunities installed in the region to support job growth and innovation in the sector. The Argyll Rural Growth Deal[197] also outlines a number of aquaculture, marine science and fisheries proposals, such as investment in critical marine infrastructure to support nearby industry, the delivery of a new aquaculture business incubator hub at Machrihanish, Kintyre, and the construction of a state of the art industry training centre in the European Marine Science Park. In England,

[194] https://www.gov.scot/publications/saltire-tidal-energy-challenge-fund/pages/eligibility-criteria/

[195] https://www.scottishaquaculture.com/apply-for-funding/

[196] Stirling and Clackmannanshire City Region Deal, Heads of Terms Agreement (2018)

[197] Argyll Rural Growth Deal (2018)

Regional Growth Deals and Local Growth Funds have also been used in some parts to renew coastal infrastructure, e.g. in Dover.[198]

Support gaps and issues

5.17 Though many support mechanisms are available to the UK marine sector, support gaps and issues do currently exist. For instance, some support mechanisms set out specific criteria in terms of funding eligibility, with references to such criteria made in the previous section. The LIFE programme, for instance, typically does not cover proposals for small projects with total costs below €500,000, meaning smaller projects tackling marine and coastal management would likely have to find another funding source. Some support is also precluded by geography, particularly when it comes to funding, for instance eligibility for Horizon 2020 funding requires applicants to be a consortium made up of at least three organisations from different countries.[199] Interreg programmes – both cross-border and transnational – also have similar requirements for partner organisations from a minimum number of member states.

5.18 Concerns have been raised around the EMFF over the perceived lack of substantive funding for areas such as data collection, data control and increased protection of fish stocks and the marine environment.[200] This issue was flagged by stakeholders through the research consultation programme. There is a perception that though significant proportions of the current EMFF allocation is dedicated to supporting monitoring, control and enforcement, as well as the improvement and supply of scientific knowledge and collection and management of data (under Priority 3), there has been little effect in this area.

5.19 A further issue highlighted by stakeholders was the eligibility criteria around participation in EMFF projects. As with many EU funding programmes, large enterprises are precluded from participation (though in some instances they can be observers on projects). Low de minimis thresholds also prevent research and innovation active businesses from participation in successive projects. The perception is that this prevents projects from generating the maximum possible impact. A number of stakeholders in England and Scotland argued that this effectively excludes a large number of seafood processors, as well as some fishing businesses. It was felt that the consequence of this was that potential impacts were not maximised; however, this view does not acknowledge the issue of how impacts would be distributed on a spatial or individual company basis, were larger companies able to participate. Nevertheless, a mechanism such as a sliding scale of intervention – similar to that in some Horizon 2020 funding strands – may be a means to allow participation of larger fisheries and seafood processing businesses in projects supported by future mechanisms of this kind.

[198] https://www.southeastlep.com/project/dover-western-dock-revival/

[199] https://www.gov.uk/business-finance-support/horizon-2020-business-grants-uk

[200] https://www.clientearth.org/eu-fund-proposal-would-artificially-keep-unsustainable-fisheries-afloat/

5.20 The availability of funding across a number of support mechanisms, notably those at EU level, is likely to be impacted by the uncertainties around Brexit, and the UK's likely departure from the EU and its financial and technical support mechanisms. For instance, a no-deal Brexit would impact the UK's eligibility for funding from the LIFE programme, with a risk that funded bodies or organisations would have to participate in projects with existing funding eliminated, or leave projects entirely. The UK Government has guaranteed to fund LIFE project bids submitted by UK organisations and approved by the European Commission while the UK is still a member of the EU, as well as LIFE funding due to UK organisations working as partners in projects led by other member states and those given funding before the end of 2020. Similar assurances have been provided over the participation of research organisations, higher education institutions and innovative businesses in Horizon 2020. Though the UK Government previously committed to "establishing a far-reaching science and innovation pact with the EU, facilitating the exchange of ideas and researchers", this nevertheless poses a threat to future funding revenue streams for research and innovation beyond the 2014-2020 programme period. It remains unclear what access UK organisations will have to the European Commission's future research framework programme.

5.21 There is also no clarity on future participation in Territorial Cooperation Programmes beyond 2020. These programmes have facilitated a number of innovative coastal projects around the UK, such as MaxiGreen through the Interreg IVa 2 Seas Programme.[201] The continued uncertainty around the impact of Brexit on future involvement in the programme may further constrain access to support for sustainable development of coastal areas.

5.22 Stakeholders also voiced a serious concern that exiting the EU without a withdrawal agreement would result in complete loss of access to EU funding support mechanisms in future.

5.23 At the outset of the Brexit negotiations process, it was anticipated that there will be a shift in focus to opportunities with Official Development Assistance (ODA) eligible countries to better target international aid to drive collaborative work. However, there has been little development on this front in recent years.

5.24 There are also some concerns over the funding process of mechanisms. For instance, concerns have been expressed over the Coastal Communities Fund's bidding process with a perception that it favours larger communities and that the Fund's short-term nature meant support for more holistic and sustainable approaches to regeneration in coastal areas lacked long term impact.[202] The bidding process of some other funds was also flagged by stakeholders as an issue, particularly where a two-stage process existed, requiring bidders to first submit an expression of interest. This often time-consuming and resource intensive approach acts to deter organisations and particularly businesses from applying, thereby acting as a barrier to innovation.

[201] http://archive.interreg4a-2mers.eu/approved_project_161222456.pdf?id=16122

[202] https://publications.parliament.uk/pa/ld201719/ldselect/ldseaside/320/32009.htm

6 Priorities and action areas

Introduction

6.1 The preceding chapters have set out an overview of the marine economy, presenting the main structural and transitory challenges and constraints identified in the research, and summarising the main technical and financial support mechanisms that currently exist. This final chapter identifies the priority themes and areas arising from the more structural challenges that government agencies, departments, devolved administrations and other strategic public sector partners should consider to address market failures and constraints to sustainable development of the UK's Marine sectors.

6.2 The purpose of the discussion in this chapter is to highlight where support can be focused to target genuine market failures, blockages and constraints where public sector intervention is justified, and issues cannot be overcome by business alone. It will enable the UK Government and devolved administrations to work towards realising objectives, priorities and policies (adopted and proposed) set out in a range of strategies and plans, including:

- UK Government (2018) A Green Future: Our 25 Year Plan to Improve the Environment;
- UK Government (2018) Sustainable Fisheries for Future Generations;
- Scottish Government (2019) Future of Fisheries Management in Scotland;
- Welsh Government (2019) Brexit and Our Seas; and
- Marine Plans for England, Scotland, Wales and Northern Ireland.

6.3 It is not within the scope of the work to make recommendations on potential interventions or the shape of future support mechanisms. This is a task for Steering Group members flowing from this report, and aligned work being undertaken in parallel with this research.

Summary: the marine economy in the UK

6.4 Marine sectors in the UK are an important component of the economy, helping to drive economic growth in coastal areas and through the supply chain, across the UK overall. The marine economy has great potential for future development. A number of marine sectors have demonstrated strong growth, and this can be continued with the correct support.

6.5 There are significant and emerging global drivers of growth in the marine economy and so opportunities for the UK. The key ones are increasing global demand for protein, especially fish, a demand for more plant-based food products, pharmaceuticals and cosmetics, non-plastic packaging, clean renewable energy, and

increased and changing tourism, including marine based tourism. These may transform the way we look at the marine sectors, even in the near term.

6.6 However, there are undoubtedly constraints and challenges to growth and safeguarding of natural resources that must be addressed in order to realise the potential impacts and benefits from the sustainable development of the marine economy and the UK's marine assets and capabilities. Some of these are transitory, and many are related to the continuing uncertainty and anticipated impacts of Brexit. However, many are more structural, and can be categorised across a number of capital themes:

- Access to **human resources** and the necessary skills and expertise to work in and develop marine sectors, in the places where it is needed – often, but not always, away from major population centres;
- Sustainable use and conservation of **physical and natural resources**, to underpin not only economic activity, but the social and environmental well-being of coastal areas and communities;
- Production of and access to **more robust and accurate data** about the natural environment and resources that the marine economy relies on, as well as data about the impact that each of the marine sectors has on the natural environment;
- The necessary **infrastructure** to underpin economic activity in each of the marine sectors, some of which require co-ordination across marine sub-sectors;
- **Technological development** and adoption to drive more efficient operations and so enhance productivity and use of resources, and conserve the marine environment wherever possible. This is critical to ensure sustained international competitiveness;
- Access to **finance** to fund investment to maximise opportunity and increase productivity and efficiency, to enable product or device development to demonstrate market readiness and commercial viability, and to enable scale-up of operations, especially in emerging value chains;
- The right **political support** and productive **co-ordination and relationships** between interest groups, sectors and government, often including active rather than passive market structures, to better enable sustainable development, based on robust evidence of what sustainable development actually looks like in the marine and coastal environments; and
- Addressing threats to **social licence** and the links between the marine sectors and communities and society in general, arising from partial knowledge and understanding of the activities undertaken by businesses, where collaborative working between industry, the public sector and communities (a triple helix approach) needs strengthening.

6.7 The following section explores areas where government intervention can address structural market failures and constraints where business action alone is insufficient to overcome challenges.

Priority themes and action areas

Recognising the interdependencies in the marine economy

6.8 Marine sectors are inextricably linked by overlapping spatial requirements, yet are not always tightly integrated and usually are subject to very different regulatory systems. There is scope for more cross-sector engagement and collaboration which would help plan and balance the different uses and users, and ensure the sustainability of the sector overall, managing environmental impacts. This will help to improve communication across industry stakeholders and strategic/public sector partners, therefore enhancing cross-sector understanding, and improving trust between sectors and industry actors. It is possible that emerging national marine plans will go some way to achieving this.

6.9 There is increasing vertical integration in commercial capture fishing, aquaculture and seafood processing value chains, particularly in England and Scotland where larger companies exist. There is 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. Access to ownership and financing will influence outcomes in this process, and this is a key consideration for governments and public sector bodies in terms of concentration of impacts, sustainable development and the pattern of inclusive growth.

6.10 From a public investment and intervention perspective, there are gaps in knowledge and co-ordination where the public bodies managing the shared marine resources can play a role in providing clarity. The marine space as a market place requires co-ordination, so investment in associations, regulatory bodies, monitoring and proactive spatial management would help to address this constraint to sustainable growth.

6.11 Additionally, governments and public agencies should give greater consideration to the potential for co-location and clustering of different marine uses and cross-sectoral benefits. 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.

Recognising differences in the marine economy

6.12 Despite the interdependencies and the common challenges faced across the marine economy, there are geographical and sectoral differences that need to be

recognised by any future support mechanisms and interventions. For commercial capture fishing, there are clear differences between UK countries in terms of catch, fleet size and age, and also workforce characteristics. Aquaculture is split in two ways: between the scale and maturity of the sector in Scotland versus elsewhere in the UK, and also between finfish and shellfish (this is particularly the case for Scotland, which makes up a much larger proportion of aquaculture). In processing, large companies based in England and Scotland have different needs than small and mid-sized ones found elsewhere in the UK. Similarly, for marine renewable energy there are very different support requirements for the emerging wave and tidal energy generation sub-sector than for offshore wind, which is more established.

6.13 It is critical to recognise these differences to design and deliver the right combination of support to ensure sustainable development at a regional and country level, as well as for the UK as a whole. Support should be responsive to the different needs within the marine economy and the industries and actors that it comprises. Governments and agencies should therefore give cognisance to the specific geographical and sectoral needs across the UK's marine economy.

Co-management of resources

6.14 Taking an approach that recognises both the interdependencies and differences of marine sectors will require a strong partnership approach across the public sector, industry and research organisations, including academia. Co-managing marine resources should be a joint responsibility for all those involved. Increasing the level of industry responsibility is perceived to encourage better and more pro-active compliance and so there are likely to be benefits if public bodies encourage and enable businesses and industry representative organisations to assume more ownership and accountability for resource stewardship and management. The development of bottom-up codes of practice could be one means of achieving this.

6.15 This should extend to the development and application of circular economy principles, to reduce the incidence of marine litter, and identify uses for by-product from aquaculture and seafood processing for example. Circular economy principles are likely to be central to marine sectors but they require co-management and have potentially complex regulatory and operational implications between sectors.

Fit-for-purpose infrastructure

6.16 Marine economy industries are developing fast, but the lack of adequate infrastructure is a constraint to growth that could see the UK lose international competitiveness. Regenerating and modernising ports is a critical area where public sector support is necessary. Some steps have been taken, e.g. through growth deals, to undertake improvements to smaller ports and there are plans for more investment and development. However, a more proactive and co-ordinated approach should be considered to overcome what is a significant constraint to commercial capture fishing and other marine sectors and uses such as cruise and

other marine tourism, renewable energy and Oil &Gas decommissioning in terms of facilities that are often necessary to realise opportunities and operate efficiently and safely. Taking a strategic approach to bringing port and harbour infrastructure up to date will also address health and safety concerns, and enable a greater degree of diverse users and uses.

6.17 More broadly, governments and public sector bodies should give consideration to the wider infrastructure needs that underpin marine sectors. Whilst ports are the focus, supporting infrastructure such as transport and digital connectivity are also critical for productivity, efficiency and access to markets.

Application of technology, data collection and evidence

Enabling new technologies

6.18 Relying on out-of-date and inefficient equipment is a constraint to growth, especially for seafood production, harvest and processing. Trialling new devices and gear is a key area where government assistance is required, not just for investment but for regulatory and governance reasons. This is important if the UK is to compete in the global market place and not lag behind countries where there is support to test and deploy innovations in gear, devices and processes. This includes where there is a lack of clarity on whether testing may contravene legislation and regulation, and where it does, what mechanisms can be put in place to allow for 'testing in the field'.

6.19 Public bodies should therefore explore ways in which there can be a strategic approach to provide the necessary frameworks, permissions and incentives for industry to trial new equipment. An example is in commercial capture fishing, where there is a reported reluctance on the part of skippers to test out new gear in 'live' conditions in case they contravene regulations and run the risk of sanctions.

6.20 The UK has a strength in marine economy science and research but it is not always well aligned to industry need and so does not support sustainable growth of the sector as well as it could. The public sector has a role in ensuring greater support for industry-focused and applied R&D. By ensuring that more research is planned and undertaken in partnership with industry, and focuses on identified sector-specific and cross-sector challenges, technological, environmental and marine biological constraints will be more effectively addressed which will benefit the development of the marine economy. Government and public sector agencies also have a role in supporting proactive and positive academia-industry relationships, and encouraging co-opetition[203] between businesses to benefit whole-sector development. This may also serve to accelerate the trickle-down of technology advancements to smaller companies who may not have the resources to be actively engaged in R&D and innovation.

[203] Co-operation between competing companies to secure a market advantage for both individual businesses and sectors within a particular region or country, without engaging in anti-competition practices or behaviour.

Data, monitoring and evidence-based decision making

6.21 There is a strong sense that whilst considerable data is collected, for example 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. Currently, management is largely based on the precautionary-principle, which of course has its place. However, without a very robust and credible evidence-base, it is likely that the UK is not maximising the opportunities, and there is 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.

6.22 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.

6.23 With specific reference to marine tourism, greater levels of research and monitoring is required to understand the impact on coastal locations. This will help to better manage the volume of visitors to these areas. Also, changing attitudes to air travel as a contributor to climate change could mean more tourism in coastal communities across the UK as tourism shifts towards UK-based and local travel. Conversely, it could also mean that fewer tourists visit the UK although there is currently no evidence of this. Improved monitoring can help destinations plan and respond to changes in visitor demands on marine and land-side areas. Government's role here would be to ensure that research is not undertaken in piecemeal fashion, but in a co-ordinated way and to a sufficient level of robustness. This will cover planning what data is needed and at what level, and how it will be collected, analysed, used and disseminated.

Addressing the workforce and skills supply challenge

6.24 An inadequate supply of skills is a critical market failure across the marine economy. There are two key issues here: the perception of the sectors and the career opportunities available, and ensuring the skills supply through education and training provision that meets industry requirements.

6.25 Marine sectors are not often seen as positive career destinations by potential recruits and the people who influence their career choice. This is often due to out-dated misconceptions about the roles and types of tasks, the working conditions, and lack of clear career progression. In reality, there are a wide variety of roles across the marine economy and the supply chains that support each sector, as well as progression opportunities in terms of skills role development and career

advancement. New technology, for example automation and digital technology, means that many of the processes and therefore tasks have changed considerably and are arguable more attractive. To attract people and to foster visibility of career opportunities and pathways, marine sectors as career destinations must be clearly communicated and reinforced amongst potential recruits, people and organisations that influence career decisions. In the case of aquaculture and seafood processing in particular, they should be promoted as increasingly technology-driven and less reliant on manual labour. This may also open up the opportunities to a more diverse workforce, for example encourage more women to work in what has traditionally been male dominated environments, and vice versa.

6.26 Allied to this, there is a priority for governments and public sector agencies to ensure that education and training provision can respond proactively and flexibly to sector needs. As there is increasing dependence on digital technology and higher-level skills, providers must position themselves to meet this need. Public bodies are ideally placed to encourage and facilitate this. Whilst the focus of this work has been on immediate issues for the marine economy, more broadly there is a need for governments and public agencies to ensure that the necessary infrastructure is in place to help attract and retain a skilled workforce in coastal areas, e.g. affordable housing, services, digital connectivity, etc.

Stimulating marine sector investment

6.27 A lack of investment and access to finance is a persistent constraint for many marine sectors. Governments and agencies should explore ways of enabling and encouraging commercial lenders to enter the market more readily. One way of achieving this is to provide investment incentives for businesses to make investment more affordable. Another strand is for the public sector to provide access to gap funding, or act as a junior lender in loan funding arrangements between businesses and commercial lenders to share the risk and so increase confidence to invest, particularly where markets are not yet commercially viable, e.g. wave and tidal energy, seaweed cultivation and harvesting. A successful example is the Renewable Energy Investment Fund (REIF) in Scotland, now superseded by the Energy Investment Fund (EIF). This type of approach may require the public sector to consider its attitude to risk differently in order to attract investors. Any risk can be offset by potential returns in turnover, employment and GVA gains.

6.28 Public sector bodies could also draw on best practice examples to actively develop financing models to engage in specific sectoral needs. This could include financing of boat purchases in the inshore fishing sector, modernisation of equipment and adoption of technology in seafood processing, or to finance growth of UK-based firms in the aquaculture supply chain. This may also extend to mechanisms such as shared ownership models for equipment, akin to the machine rings that exist in agriculture. This can help to overcome financial barriers for new entrants, or where businesses are looking to expand. Such measures will help to drive efficiency and productivity, and raise operational standards.

6.29 There is also a clear need for public agencies to work with banks and other commercial lenders to increase understanding and awareness of investment requirements across different marine sectors. At the very least, this can affect UK competitiveness against international competition where internal or externally funded players can gain advantage and crowd out UK-based businesses. Few lenders demonstrate an awareness of sector-specific investment requirements, and therefore a willingness to engage with these markets. By entering into a programme of dialogue, governments and agencies can help to overcome this information failure.

6.30 Where a critical mass and scale of development projects is a barrier to investment, public bodies can help to make investment more attractive by working with industry on the pooling of projects, for example in aquaculture, especially in England. The extent to which this requires large-scale intervention is unclear, however, and there may simply be a need for facilitation to enable project partnerships to develop across businesses – and potentially sectors as well.

Responding to and changing consumer preference

6.31 Bringing about change in consumer eating habits could expand and open new domestic markets for commercial capture fishing, aquaculture and seafood processing. Whilst industry can undertake advertising and educational engagement programmes, the degree of behaviour change required is too large-scale and long-term for industry to sustain by itself. Governments and public agencies could therefore give consideration to the ways in which it can support and encourage consumer behaviour change to drive growth opportunities for the seafood marine sectors. This also contributes to the public health and healthy eating agenda.

Change to approach of support and intervention

6.32 A key message arising from the research was that a change in the way existing financial support mechanisms operated was desired by industry. Governments and managing authorities for financial support mechanisms should therefore give consideration to the following:

- Greater access to support for start-ups and new market entrants, to foster entrepreneurship and overcome challenges associated with necessary financial outlay for entry to sectors such as commercial capture fishing or aquaculture;
- A sliding scale of intervention by business size or project contribution, to allow participation by larger businesses, where this can positively affect benefits realised through the project, and the subsequent distribution of impacts. This requires an understanding of where there are weaker points in each sector, even where there are stronger parts of the sectoral value chain; and
- Ring-fencing of support for specific sectors, so that there isn't undue advantage for one sector or technology over another.

Summary statement

6.33 As demonstrated, the marine economy has great potential. There is currently a period of uncertainty, but underlying that, there are a number of structural issues that need to be addressed in order to maximise its potential. These are being taken very seriously by the UK Government and the devolved administrations. The findings of this report help to demonstrate where future action can be taken to support the economic, social and environmental sustainability of the marine economy.

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