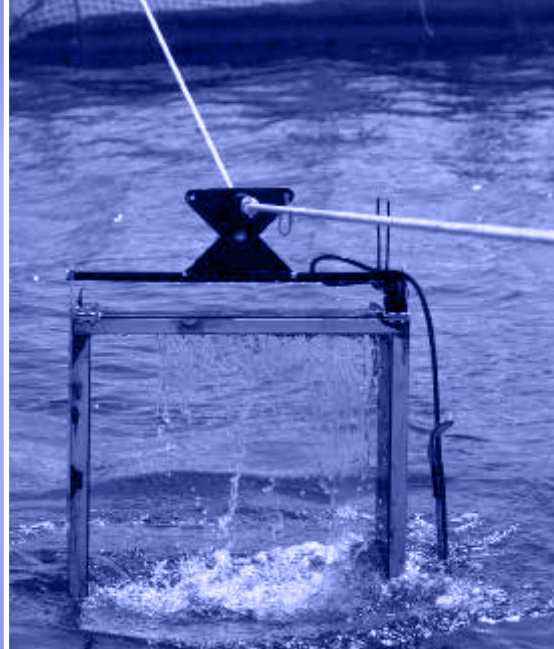


MAXiMAR:

MAXIMISING THE MARINE ECONOMY IN THE HIGHLANDS AND ISLANDS

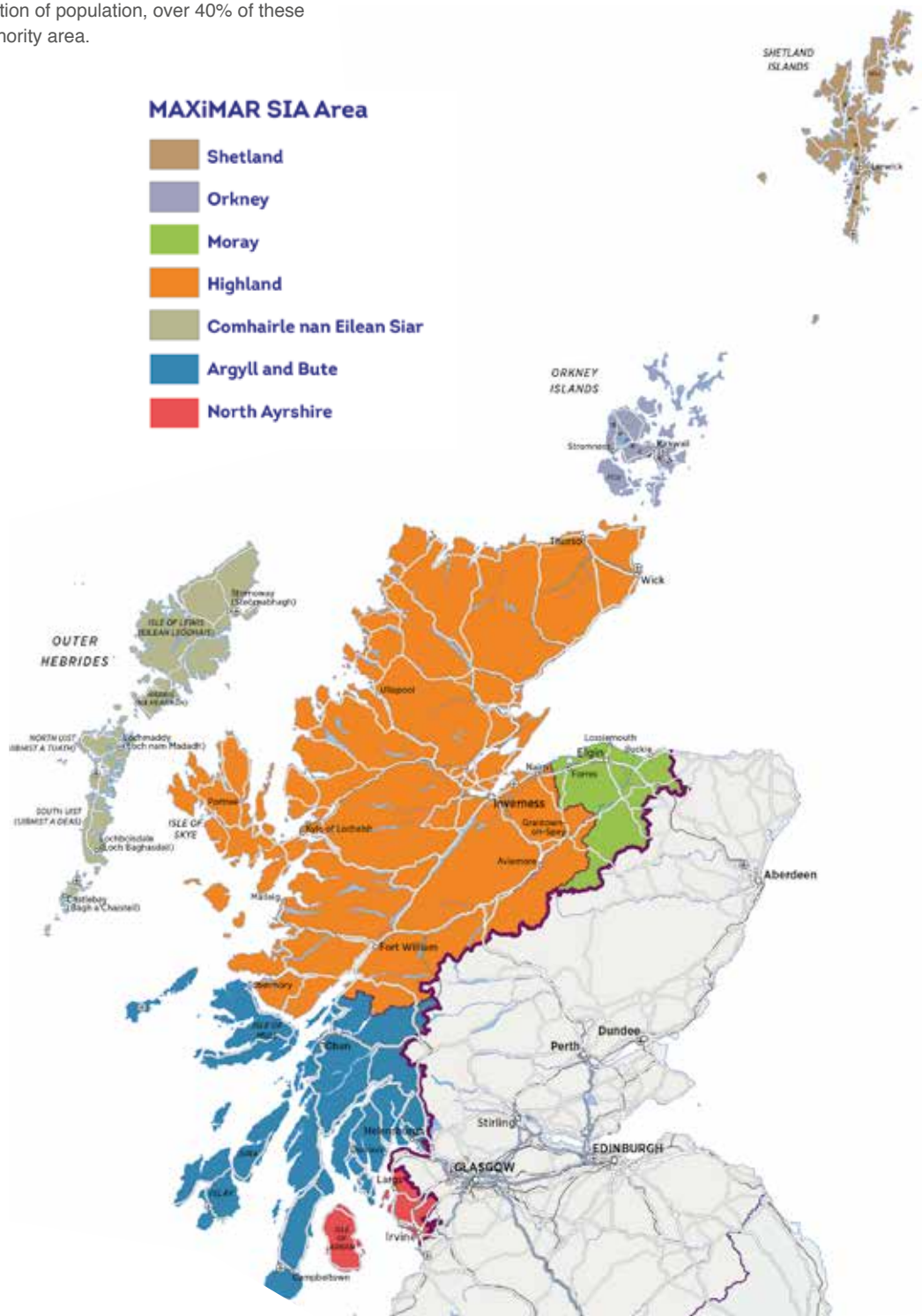
SUMMARY REPORT



SUMMARY

At just over 40,000km², the Highlands and Islands region stretches from Shetland in the north to Campbeltown at the southern tip of Argyll, and from the Western Isles to Moray in the East. In 2016 the total population for the Highlands and Islands SIA region was just over 625,000.

It is a largely rural and sparsely populated area. With a population density of around 12 people per km², in comparison to 129 per km² in the rest of Scotland, the region has the lowest population density in the UK, and one of the lowest in Europe. Of the total population, 61% are of working age (aged 16-64). This is lower than the 63% UK average and reflects the difficulties faced by the region in attracting and retaining young people. In total there were just over 300,000 jobs in the Highlands and Islands region in 2016. Reflecting the concentration of population, over 40% of these were based in Highland local authority area.



INTRODUCTION AND CONTEXT

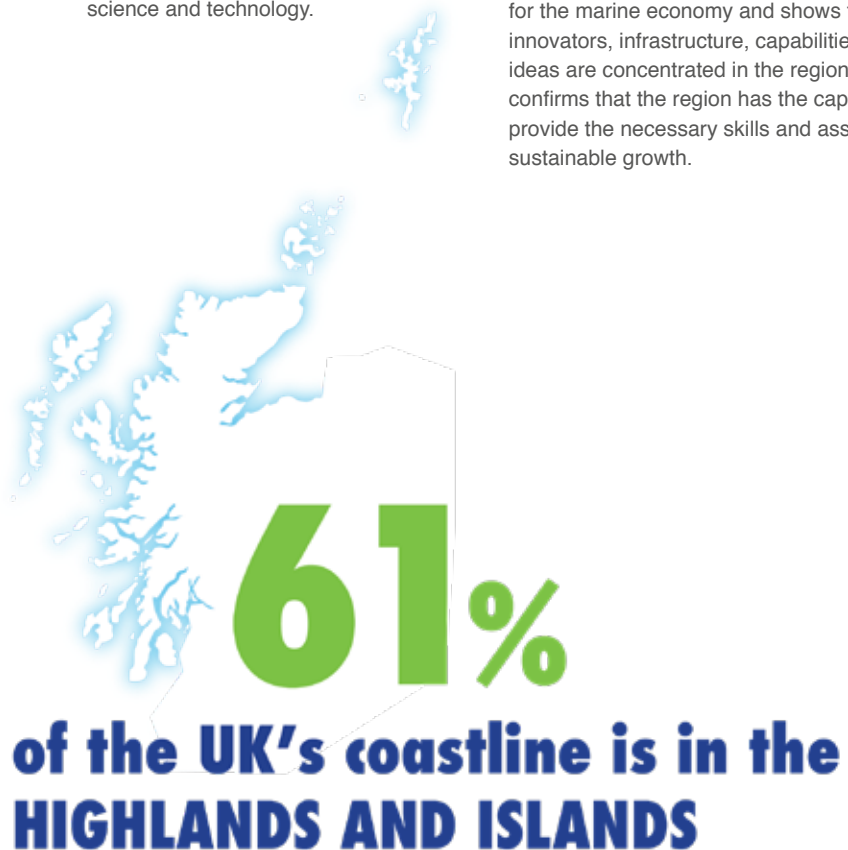
In Autumn 2015 the UK Government announced regional Science and Innovation Audits (SIAs) to catalyse a new approach to regional economic development. SIAs enable local consortia to focus on analysing regional strengths and identify mechanisms to realise their potential. In the Highlands and Islands, a consortium was formed in October 2016 to focus on our strength in the marine economy. This report presents the results which includes broad-ranging analysis of the Highlands and Islands marine economy capabilities, the challenges and the substantial opportunities for future economic growth.

There is worldwide recognition of the potential of the marine economy, for example for food security, for clean energy and to provide new solutions and a wide range of applications. It also has an enormous contribution to make to the circular economy agenda. The Highlands and Islands has an outstanding marine environment and contains almost two thirds of the UK's coastline and coastal waters. It is home to world class marine science and innovation.

The focus of the SIA is on aquaculture, wave and tidal energy and marine biotechnology which are the most highly innovative sectors in the region's marine economy. They offer the greatest growth potential and the opportunity to accelerate economic growth through strategic, focussed effort built on technological innovation.

- **Wave and tidal energy:** Scotland is the global leader of wave and tidal energy innovation, with the world's first commercial scale projects in development¹ and excellence across the supply chain. By harnessing the marine power of the Highlands and Islands region the UK will be able to position itself at the forefront of one of the untapped global clean energy industries of the future.
- **Aquaculture:** The Highlands and Islands is the largest aquaculture region in the UK, and the third largest salmon producer in the world², with the best premium for its produce. The increasing demand for fish protein is being driven by global population growth and rising affluence in developing countries. There is tremendous scope to increase sustainable production through the development and application of new science and technology.
- **Marine biotechnology:** The pristine marine environment, described as 'a huge and diverse 'underwater forest' is an extremely valuable but currently underused resource in the Highlands and Islands. It presents a huge growth opportunity with a diverse range of innovative applications in high growth, high value sectors such as health and life sciences, and energy.

Combining wave and tidal energy, aquaculture and marine biotechnology into a marine economy strategic framework will add value to each sector as well as to the region, and the UK overall. Investing now will secure Scotland's long-term position as a global leader in this field. The SIA demonstrates how the marine economy will take a place-based approach to deliver against the themes of the UK Industrial Strategy³ and the Foresight Future of the Seas report⁴. It articulates the strategic opportunities for the marine economy and shows that innovators, infrastructure, capabilities and ideas are concentrated in the region. It also confirms that the region has the capacity to provide the necessary skills and assets for sustainable growth.



1. <http://www.orkneymarinerenewables.com/crown-estate-leasing-round>
2. <http://marineharvest.com/globalassets/investors/handbook/salmon-industry-handbook-2017.pdf>
3. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf
4. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/693129/future-of-the-sea-report.pdf



VISION

With our unique marine environment and our collective strengths in science and innovation, we will work collaboratively to accelerate the economic opportunities of the marine economy to benefit the Highlands and Islands, Scotland and the UK.

In doing so, we will protect and respect the communities that are the custodians of this world-class resource.

KEY STRENGTHS

The Highlands and Islands has a rich base of marine economy science, innovation and capabilities across a number of institutions and in industry. This, combined with its natural marine assets, makes it an unparalleled destination and resource for research, and the development of new ideas. The activities in the region act as a catalyst for new, often disruptive technologies.

There is a commitment to, and strong examples of, clustering and collaboration, cross-sectorally, and between industry and research. The region has an established and strong science and innovation infrastructure with a high degree of specialism in the marine economy. As a result, it has a global reputation for research excellence and has attracted significant funding, along with world-class talent.

It is an enterprising region with a highly qualified workforce and a significant concentration of marine-economy based businesses. Growing the marine economy will increase the supply of higher value jobs and activities and will be a key component in realising UK growth ambitions. It will deliver economic and social benefits to the Highlands and Islands and help to support the sustainability of fragile communities.

GROWTH OPPORTUNITIES

The three sectors that comprise the marine economy are at different stages of development but for each, there is significant and demonstrable potential for growth. Though the sectors will grow at different rates, evidence points to a **total value of the marine economy in Scotland of £5bn by 2035**. Estimates suggest this is an approximate seven-fold increase on current values.

In **aquaculture**, the scale of the salmon industry drives much of the innovation investment, both for expansion (new cage design, smolt (young salmon) production, sites in more challenging locations) and tackling challenges (disease control). The industry in Scotland aims to double the value of production by **2030 to £3.6bn**. Key to achieving the expansion will be tackling the issues through science and innovation.

Wave and tidal energy is moving into a new phase of innovation where it is seeking to commercialise and export knowledge, to 'capture the value' of new device innovation and systems learning to date. Current estimates indicate a potential value to the UK of **£800m by 2035**.

In **marine biotechnology**, significant applications are in early development and could impact across a range of high profile and important areas such as energy, human health, and food production. The potential value to the Highlands and Islands is expected to be **£600m by 2030**.

But it is not just the Highlands and Islands that will benefit, the marine economy in the region drives activities in, and impacts on, other parts of Scotland and across the UK. It also supports an extensive and diverse supply chain generating economic benefits and providing a wide range of employment opportunities.

Interdisciplinary capacity and the recognition of translational research opportunities are key to accelerated progress in the marine economy. The relatively small size of Scotland and the existing channels of communication make this more readily achievable. Smart technology in terms of unmanned vehicles, miniaturised sensors, data capture and pre-processing, and the handling of large datasets are core abilities that translate across each sector. Examples already include environmental and oceanographic monitoring, survey and planning.



The Highlands and Islands is the **THIRD LARGEST SALMON PRODUCER** in the world



£16.09m

THE VALUE OF **MARINE BIOTECHNOLOGY** PROJECTS LED FROM THE **HIGHLANDS AND ISLANDS**

<http://mar...>
<http://ww...>

TARGETED OPPORTUNITIES

The Targeted Opportunities have been developed with industry, education, the public sector and other key stakeholders working collaboratively. They address the particular challenges for the marine economy in the region. They are based on identified need, rather than being developed to target particular funding streams, however, they align with regional, Scottish and UK policy objectives. They will also be aligned with the developing Regional Deals in the Islands (Orkney, Shetland and the Outer Hebrides), Argyll & the Isles, and Moray. By driving these forward, the marine economy will contribute to the transformation of food production and clean affordable energy. Marine biotechnology also has a potential role in helping to meet the needs of an ageing population through innovations in human health.

Overarching the opportunities is the proposition that the marine economy should be developed by taking a whole-sector approach, for example to strategic planning, science and innovation, operations, funding and problem-solving. There is a great deal of intelligence, knowledge and experience in each sector. However, it is largely kept within each sector and in many cases, within individual institutions. Integrating the three sectors and adopting a strategic approach for the marine economy will enable this knowledge to be better shared between industry, academia and the public sector. Importantly, the community will form the fourth element of this quadruple helix so that the marine economy works with communities where possible and appropriate.

Flowing from the SIA will be a strategic plan for accessing funding for science, innovation and growth of the marine economy. There will also be a opportunity to support and influence the development of a Sector Deal for the Marine Economy. We have developed four Targeted Opportunities; the first has three strands flowing from it.



GAP ANALYSIS

There is undoubtedly enormous potential for the development of the marine economy in the Highlands and Islands. However if the benefits for the UK are to be maximised and the economic benefits realised, there are some clear challenges that must be addressed. Failing to do so will inhibit growth and have a negative impact on the economic and social health of the Highlands and Islands. There is currently a lack of clear routes to commercialise innovations and new technologies; there are some skills and gaps that will need to be addressed to make sure there is an adequate workforce to fuel sector growth; and current planning and regulation is working against innovation, commercialisation and expansion. There are some good examples of cross sector science, innovation and operational activities. However there is enormous scope to make much, much more of this by catalysing, clustering and capitalising on the wide range of the known, as well as the currently unanticipated opportunities.

With these gaps and issues in mind, four hypotheses of the MAXIMAR SIA were developed to provide a holistic and systematic framework to address the challenges in terms of:

- Having the mechanisms in place to support the commercialisation of the marine economy science and innovation assets and so realise the economic potential for the region, for Scotland and for the UK.
- Implementing a planning and regulatory framework that supports and encourages innovation and development, balanced with environmental sustainability and the needs of different user groups.
- Identifying opportunities and developing marine economy clusters in science, innovation and operations building on the strong networks and relationships in the region.
- Making sure that the right skills, education and workforce development opportunities, science and infrastructure are in place to fuel marine economy growth.

This is all achievable, it is within our grasp and there is the determination amongst the stakeholders across Scotland to work together to ensure that the opportunities are maximised.

1: REGIONAL CLUSTER MODEL FOR MARINE INNOVATION, TECHNOLOGY AND SKILLS

THE CASE

Industry has expressed a need for access to high quality, state-of-the-art facilities, equipment and wider infrastructure to drive enhanced R&D and aid clustering, close to the marine environment. A number of key locations in the region host research and technology organisations which already support this, but they are not currently sufficiently resourced. There is a strong case for a major cluster development incorporating technology and sea-trial testing facilities and industry support mechanisms. It will incorporate enhanced marine training and skills development provision which will scale up training provision in the Highlands and Islands, and will align with other training providers across Scotland. There is an opportunity to develop an innovative partnership model that builds on the combined existing infrastructure to better meet the needs of industry, grow innovation in the sector, extend and expand the skills base, and attract new business to the region. A key element will be a pilot test site to explore the potential for, benefits of, and associated risks of clustering marine economy activity across the sectors, for example, use of drones and robotics in areas that offer different marine characteristics. New approaches would be developed, deployed and monitored, and lessons learnt and applied in the region and further afield.

The regional cluster model would create the conditions to maximise innovation and support growth of the marine economy. It would facilitate collaboration and cross-sectoral working, provide a route to market for innovation and research, encourage entrepreneurship and business development. It would also add value to the existing innovation-supporting infrastructure.

Underpinning the regional cluster model will be three critical strands:

- Targeted Opportunity 1a: Workforce development
- Targeted Opportunity 1b: Blue economy infrastructure investment plan
- Targeted Opportunity 1c: Science, research and industry: scale and alignment

1A: WORKFORCE DEVELOPMENT

There is potential to better exploit and facilitate cross-sectoral working, training and development, as well as workforce movement between sectors. There is also a need to understand current and emerging skills gaps and training requirements. This requires scaling up the provision of education and learning in the Highlands and Islands to anchor skills development in the region, align need with opportunity, and address both replacement and expansion demand in the labour market. This, along with upskilling the existing workforce to keep pace with new processes and developments is a key issue identified by industry and public sector partners, and one that the current skills system is not meeting. It will capitalise on the activities and partnership working of the network of marine training centres across Scotland.

1B: A MARINE ECONOMY INNOVATION INFRASTRUCTURE PLAN FOR SCOTLAND

Mapping the existing infrastructure to better understand current provision, and how it aligns with need will be critical in developing a targeted and proactive plan to ensure appropriate infrastructure is in place to develop and grow the marine economy science and innovation opportunity. This will be integral to the regional cluster model and will be driven by industry needs. It will identify the infrastructure, equipment, facilities, incubation and soft-landing space required across the three sectors, and include costed proposals targeting appropriate funding opportunities. The economic impact of a well-researched innovation infrastructure investment plan will be measured in terms of employment, productivity and GVA over a 30-50 year period, and this planned approach will accelerate realisation of the economic and social benefits generated by the marine economy.

The required capital investment will link to existing regional strategic infrastructure such as the European Marine Science Park, the European Marine Energy Centre and the Orkney Research & Innovation Campus.

1C: SCIENCE, RESEARCH AND INDUSTRY: SCALE AND ALIGNMENT

Marine economy research undertaken in institutions is often not well-aligned with the current and emerging needs of industry. There is a perceived imbalance between science that focuses on environmental factors and that which focuses on technology, process and product development. The current scale of research taking place in the region is also insufficient to meet the needs of the sector and so needs to be increased as well as better aligned. Academic research, located in close proximity to industrial activity, is a proven requirement. The regional cluster model will be central to delivering this. Two key components are required to ensure proper alignment of the science and research base in the region – ensuring it is industry-driven and ensuring that there is capacity to broaden the research activity. Both have been identified as key to accelerating the use of new technologies across the three sectors.

This will require growing the number of principal investigator and post-doctoral opportunities in the region at the various innovation sites, and providing collaborative challenge funding to encourage industry engagement and ensure focus is on the right industry challenges.



2: ROUTES TO MARKET

THE CASE

The marine economy in the MAXIMAR SIA region has enormous potential with an international reach. However, each of the three sectors faces challenges in terms of realising the potential and commercialising innovation.

The Highlands and Islands has the potential to produce large quantities of **WAVE AND TIDAL ENERGY** and contribute significantly to the development and provision of clean energy to UK and international markets. New technology is being developed and tested in the region and there is a need to optimise its value. However, the dated infrastructure to get the energy to market is inhibiting production, innovation, testing and development. There are four elements to this opportunity: connecting the production areas to the National Grid; providing a range of 'routes to market' support mechanism for example through Contracts for Difference, time limited enhanced fee tariffs and/or through the tax system; bringing activities that need power to the source, rather than relying on the power being routed to the activities; capturing the potential of hydrogen production from wave and tidal as a power source.

MARINE BIOTECHNOLOGY is the least developed of the three sectors and has enormous largely untapped potential. Despite its assets, the UK trade balance for marine biotechnology is negative and worsening as a result of persistent failure to remove the barriers and challenges to commercialisation of marine biotechnology science and innovation.

The Targeted Opportunities in in the SIA will be an important toolkit for addressing some of the barriers i.e. planning and regulation and an innovation cluster. However, specific mechanisms will be established to support marine biology enterprises to develop and take their products to market. It will include specialist scale-up support and support to access financial investment and de-risking strategies.

AQUACULTURE is relatively well established as a sector and very well established in the region, with many large vertically integrated producers. However, small scale innovative companies and entrepreneurs in Scotland face structural and geographical barriers to access the Scottish market. They frequently have to take their innovations overseas and sell them into competitor markets.

This impacts on the companies and means that the UK and the sector in Scotland is losing the benefits of the innovations and potential gains in efficiency and productivity, and subsequently losing global market share. Increasing the active support for collaboration between the small innovators and the larger companies will raise awareness of the innovative work and opportunities, leading to joint projects.

In addition, financial mechanisms to temporarily reduce the cost to larger companies of testing new innovations would help to remove some of the barriers.

This opportunity and the objectives and activities within it will increase the economic value of the Scottish marine economy. It will allow more enterprises to commercialise their innovations and increase the number of enterprises active in the market. It will also help to exploit international markets.



3: REFRESHED PLANNING AND REGULATION FRAMEWORK FOR THE MARINE ECONOMY

THE CASE

A highly successful process for the planning and regulation to support the deployment of wave and tidal machines in our coastal waters in Scotland is already being implemented. Learning from this and applying new approaches across the wider marine sector could be advantageous.

There is important learning from other countries on developing and implementing proactive planning and regulation that supports sustainable development. A strategic, refreshed framework is key to facilitating innovation, research and development, taking an active management approach, through a process of survey, deploy and monitor, supporting a collaborative approach between regulator(s) and science, innovation and industry.

This will require the acceleration of decision-making and reduced costs from a refreshed regulatory framework agreed to the public and private sector. This would lead to the faster realisation of economic benefits generated by the industry, as well as increased productivity through a reduction in unnecessary regulatory costs.

4: A REGIONAL MARINE ECONOMY PROSPECTUS

THE CASE

The Highlands and Islands has very strong, and in many ways unique marine economy research capabilities, opportunities and assets. It also has a global reputation for some of its activities and products, but crucially there is a lack of informed knowledge and detailed understanding, worldwide, about its marine specialisation. There is also a lack of an accurate understanding about the research and career opportunities offered by the marine economy in the region amongst both local residents and those living, working and studying out with the Highlands and Islands.

The prospectus will help the region promote itself globally to a range of audiences. It will also be a tool for individual organisations, including industry partners, to use.

This will help to attract new research and innovation, inward investment, new enterprises, business growth and in talent recruitment and retention.



NETWORKING AND COLLABORATION

The SIA process has been enormously valuable for consortium members and wider stakeholders. It has enabled new and better linkages, communication and networking between sectors. Partners have come together at consortium meetings as well as at thematic workshops which involved broader participation, including by industry leaders. Strong new relationships have been established.

Through the SIA, Highlands and Islands Enterprise (HIE) has established a closer relationship with Marine Scotland, the Scottish Government body tasked with the integrated management of Scotland's seas. HIE now has a deeper understanding of Marine Scotland's skills, expertise and policy and how the Scottish Marine Plan aligns with the region's economic aspirations. This relationship will continue in the long term and is an extremely valuable outcome of the process.

As a result of the SIA, there is a much greater awareness of shared challenges and cross-sector synergies in marine economy science and innovation. As well as new relationships, existing relationships have been galvanised, with new activity and focus. These new and strengthened links are anticipated to make a substantial difference to the marine economy and the sectors and organisations within it.

Developing the SIA has provided an opportunity for partners to understand and think about science and innovation outside of their individual sectors and organisations and how what is happening in one sector relates to their own sector and work. Consortium members have expanded their knowledge and understanding of complementary sectors and have identified where collaboration in science and innovation, as well as at operational level, can add significant value.

The consortium members and other partners have jointly identified cross-sector benefits and how each sector can support and work with others and achieve synergy. There is now a much greater understanding of how the three sectors can work collectively within the framework of the marine economy. Importantly, there is commitment and enthusiasm amongst all partners and a sense of ownership of the shared goals.

Consortium members have substantially broadened their networks and contacts, particularly their reach in to related but separate sectors. There are examples where members have invited individuals they have met during the process to join formal networks, e.g. an economist from one organisation has been invited to join another's technical network. This would not have happened without the SIA.



The development of the SIA has supported members in their own work and in their organisations. The learning, along with the SIA report, are already being used by partners to inform strategy and planning. This is likely to increase steeply as the SIA is launched and implemented. As an example, the information captured in the audit will be used to inform the strategic direction of the pan-Scotland Business University Leaders Forum. This group was recently established, bringing together strategic leaders to identify significant opportunities for Scotland.

Consortium members also acknowledge that the SIA has been very helpful in preparing the Islands Deal bid. Another academic partner reported that their internal strategies and organisational change have been consolidated because of the process and being part of the SIA consortium has led to a growing confidence in their strategic direction.

As a result of relationships established through the SIA process, Heriot Watt University is working with other consortium members to explore opportunities for jointly supporting a new Chair in Energy Systems. The University and other SIA partners, including HIE, have developed a collaborative partnership to explore options and opportunities for the academic community to support marine economy growth in Orkney. Principals, Vice Principals and researchers, along with HIE, have been meeting regularly and a plan is being developed that is likely to attract project seed funding.

Just as encouragingly, the European Marine Energy Centre (EMEC) has engaged with a number of stakeholders in the marine

biotechnology sector – a completely new territory for EMEC and something that would not have happened without the SIA. This will offer some exciting new innovations and developments for clustering, joint working and the circular economy. The initial focus of the discussions have been around how the hydrogen produced by EMEC from excess renewable energy could be applied in the marine biology sector. It could be used for processing natural molecules to deliver a range of high value products and benefit both sectors. Early stage conversations are underway between EMEC, Xanthella and other enterprises to explore this along with other opportunities for cross-sector collaboration and clustering.

Another innovative idea that has flowed from bringing partners together to prepare the SIA is the concept of combining hydrogen with seaweed and algal derived products into the production of bio-propane. Renewable powered electrolysis produces oxygen and heat as waste products and EMEC has been discussing with the Industrial Biotechnology Centre (IBiOC) how this could be used in marine biotech processes if plants are co-located.

Consortium members and partners have been exploring how EMEC's wave and tidal test sites could be used as a growing site for marine biotech species. They have also been considering how power generated in the sea and hydrogen produced from renewable energy can support future developments and operations in marine biotechnology and aquaculture. Partners have developed a clear understanding and fresh ideas of the potential synergies between a move into offshore and higher-energy environments for fish farming and

the application of wave and tidal energy as a source of power. There is also scope for EMEC to become involved in modelling environmental conditions to test fish farm infrastructure and equipment such as cages and moorings.

EMEC and the private enterprise, Scottish Sea Farms, are exploring whether hydrogen powered fuel cells could replace diesel generators on their salmon farms, with both parties interested in a test project on Eday. It is very unlikely that this cross-sectoral, research-to-industry relationship would have been established without the SIA.

The waste products from electrolysis (heat and oxygen) could also demonstrate the case for a co-located onshore fish farm, although this is still in the concept stage. Wave power for supporting offshore fish farms is a key area of opportunity and a long term match. However, the generation technology still needs a few years of development to become cost competitive and so for this opportunity to be realised.

Although some early conversations have taken place, the partners recognise that this is only the beginning. There is a commitment to better integrating ideas, innovation and goals and for public, private and research stakeholders to work together. We are confident that the new and strengthened relationships and the deeper and broader understanding of the marine economy will continue to deliver substantial benefits. We are in no doubt that the SIA will prove to be a game-changer for the marine economy, for the Highlands and Islands and for the UK.



CLOSING REMARKS

The SIA has been an extremely helpful process and has highlighted the opportunities for the marine economy and the challenges that the public sector, industry and academia will work together to address. New relationships have been established and existing partnerships galvanised.

Through it, we have a very clear, evidence-based understanding of the marine economy and a definitive and agreed agenda to develop it in cross-sectoral partnership. We will work collectively for the long term to realise the ambitions of the SIA and respond positively to the changing context which we will undoubtedly face. We will advance science and innovation to benefit people in the Highlands and Islands, businesses and the wider economy. However, the reach of the SIA's benefits will go far beyond our geographic boundaries, to Scotland, the UK and internationally.

Developing the SIA has demonstrated our combined ability to think innovatively, challenge assumptions and be confident in the unique opportunity that we have in the Highlands and Islands. We are now ready to realise that opportunity.

MAXIMAR SIA CONSORTIUM MEMBERS



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Iomairt na Gàidhealtachd 's nan Eilean



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