Version 1.1

MUSES PROJECT

CASE STUDY 2: MARINE RENEWABLES & AQUACULTURE MULTI-USE INCLUDING THE USE OF MARINE RENEWABLE ENERGY NEAR THE POINT OF GENERATION (WEST COAST OF SCOTLAND – NORTHERN ATLANTIC SEA)

MUSES DELIVERABLE:
D3.3 - CASE STUDY IMPLEMENTATION - ANNEX 4

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30 November 2017

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

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1 GEOGRAPHIC DESCRIPTION AND GEOGRAPHICAL SCOPE OF THE ANALYSIS

In the context of case study no.2, existing and/or potential multi-use sectors cover marine renewables, aquaculture and coastal energy users, with both near- and off-shore applications. The case study area encompasses the Northern Atlantic Sea, west coast of Scotland (UK) (Figure 1).

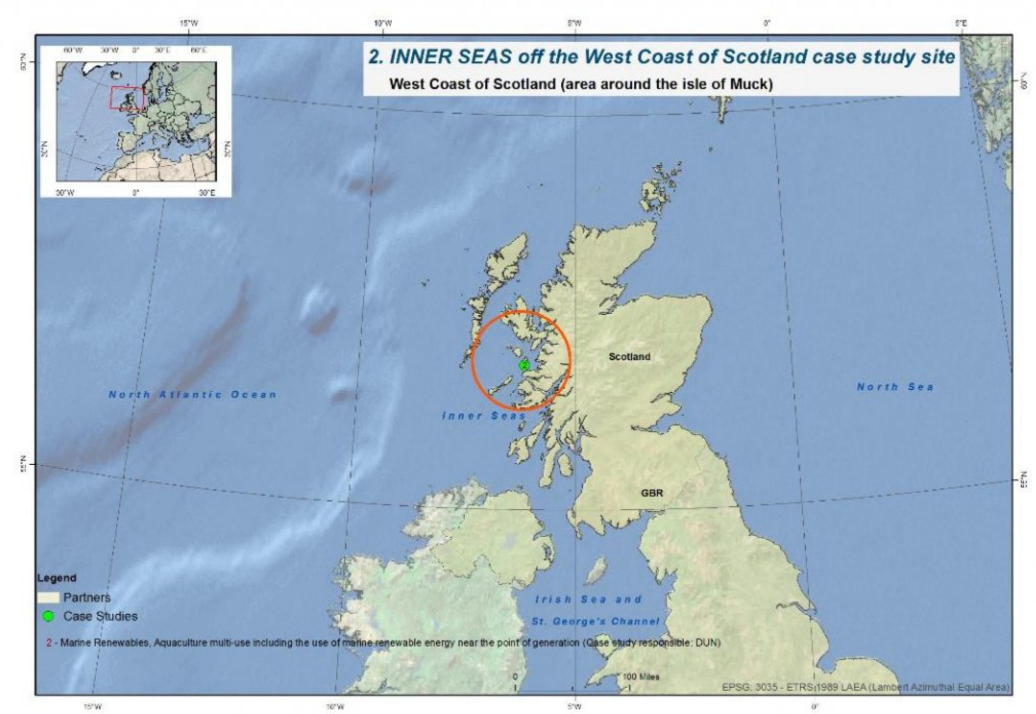

Figure 1 Location of case study area (red circle)

The analysis will focus on three multi-use combinations relevant to the study area:

- Wave energy generation & aquaculture of salmon
- Marine Renewables & aquaculture – relocation from sheltered inshore waters to off-shore waters
- Marine renewables & offshore wind supply of energy to ports & local high energy industries at the location of energy generation.

Two geographical areas are of interest:

- The near shore and off-shore of the North Atlantic off Scotland, for analysing current MU, namely Wave Energy generation and salmon fish-farms, as renewable wave energy is being used to replace traditional diesel generated power for fish-farming processes on the West Coast of Scotland.
- Further offshore locations, away from traditional sheltered sites, to explore future potential for the MU in more exposed offshore waters.

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2 CURRENT CHARACTERISTICS AND TRENDS IN THE USE OF THE SEA

The North Atlantic is largely determined by large-scale wind currents and air masses emanating from North America, creating a high-pressure area and generating prevailing westerly winds across Western Europe[1]. The continental embankments range from several hundred km in the North, with depths of the external region of the continental shelves ranging from 100 to 500m in width. Basic salinity is highest for the North Atlantic, at 35.5 parts per thousand parts. The great north-south extent of the Northern Atlantic has relatively broad areas of continental shelf with a proliferation of plant (i.e., algae) and animal species.

The North Atlantic Ocean is one of the world's busiest shipping lanes, with EU, regional (e.g. AAP) and national policy a key driver for the blue economy, where fisheries, tourism, and now energy regeneration, emerging as main economic drivers in the region[2]. Reports also state that the area could have more than double the amount of oil and gas reserves currently predicted, with extensive untapped reserves which could be underestimated by 100%. Major basins in the area are filled with geological conditions that support the formation of 'supermassive' oil reserves and the West Coast alone could provide oil and gas for at least 100 years with an estimated value of more than £1 trillion. Yet the area – off the west coast of Scotland and Outer Hebrides and Shetland – has remained largely untapped due to deep waters and difficult geological conditions.

Around 10% of Europe's total wave resource flows in the seas surrounding the Highlands and Islands of Scotland, with an estimated up to 14 gigawatts ("GW") of recoverable energy lying off the area's western and northern flanks. This potential resource has drawn wave energy device developers to the area. Also, the Scottish Government has set ambitious target of securing 100% of its electricity requirements from renewable sources by 2020, to which wave and tidal resources could contribute. The Atlantic Ocean off Cornwall and the west coast of Scotland show the greatest promise for generating electricity from the waves that crash around the British Isles, according to research. Some of the highest waves, in the Rockall Trough to the west of Scotland, measure up to 29m from crest to trough. Rows of wave "farms" up to 1,000 km long facing the Atlantic could generate around 11% of the UK's current power generation, the Carbon Trust analysis suggests. While the theoretical resource is as high as 18 GW, around 10 GW of capacity is more realistic given practical and economic constraints, said the Carbon Trust.

Algae of commercial value include the kelp genus *Laminaria*, a source of iodine, potassium, and algin; Irish moss (*Chondrus crispus*), from which carrageenan[3] is derived; including large communities of crustaceans and fish normally associated with coastal regions and which are the spawning grounds for the American and European freshwater eels of the genus *Anguilla*. Fishing activities e.g. driven by the demand for shellfish in Europe (Stornoway, Lerwick and Oban) resulted in large areas being overfished and many species depleted by the early 1990s. Seaweed harvesting remains a

1 https://www.britannica.com/place/Atlantic-Ocean/Hydrology#ref408458

2 https://www.britannica.com/place/Atlantic-Ocean/Hydrology#ref408458

3 These are linear sulphated polysaccharides extracted from red edible seaweeds, widely used in the food industry for their gelling, thickening, and stabilizing properties.

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small-scale industry in the Outer Hebrides and Orkney islands, processing over 5,500 tonnes per annum, mainly *Ascophyllum nodosum* (manual and mechanical methods).

In relation to the broader area of the case study, major maritime users and activities include aquaculture within lochs (Loch Sunart, Loch Linnhe, locations in the Sound of Mull). Regarding nature protection, the location of the development is within the Loch Sunart to the sound of Jura MPA, the Inner Hebrides and the Minches SAC, and is in close proximity to the Skye to Mull Scottish Natural Heritage (JNCC, 2017; MS, 2015a). There are no major ports in the area's broader vicinity. The harbours of Mallaig and Oban (~50 km) reported fishery landings of 4,710 and 2,728 tonnes respectively (2014) comprised primarily of shellfish (MS, 2015a). Heritage assets in the vicinity of the case study include the Mingary castle that has been designated as a historic building and the Eilean na Carraidh, Fish trap national monument in Dervaig, Isle of Mull (Historic Environment Scotland, 2017[4]). The area falls within the West Scottish Offshore Renewable Energy Region (SORER) (MS, 2012). Three areas for the development of OW and four areas for the development of wave energy are set forward by the Sectoral Plan for offshore energy in the West Region (see Figure 2). Thus, the marine renewable energy sector is likely to develop further in the study area.

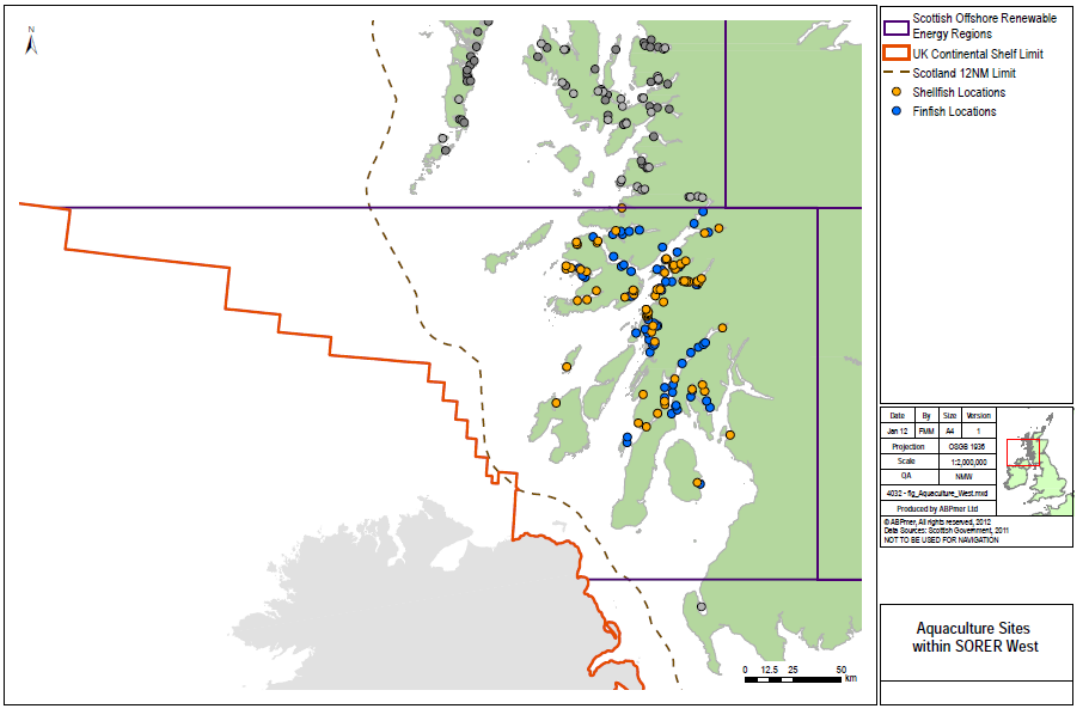

Figure 2 Aquaculture sites in the vicinity of the case study area (MS, 2012). Regional locational guidance for OW and wave for the West Region. Available at: http://www.gov.scot/Topics/marine/marineenergy/Planning/windrlg [Accessed: 22/11/2017].

4 http://portal.historicenvironment.scot/designation/SM10561 [Accessed: 22/11/2017]

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3 MU OVERVIEW: GENERAL BACKGROUND ON REAL AND / OR POTENTIAL MU(S)

3.1 *Legislative, institutional and administrative context*

The marine planning system in the UK is set up under the UK Marine and Coastal Access Act 2009 (MCAA) (HM Government, 2009) (which mainly affects England and Wales), the Marine (Scotland) Act (MSA) 2010 (Scottish Government, 2010) and the Marine Act (Northern Ireland) 2013 (HM Government, 2013) (Figure 3). Marine policy objectives are delivered through statutory Marine Plans. Plans can be either 'national' (e.g. Scotland's National Marine Plan (Marine Scotland, 2015a) or 'sub-national'/'regional' e.g. South-west offshore plan, in England).

2009	2010	2011	2012	2013	2014	2015	2016
MCAA	**MSA, MSR, SPP**	**MPS**	**NPPF, NPF3**	**MANI, Scottish Sectoral Marine Plan**	**MSP (EU), SPP**	**SNMP, SES**	**Scottish National Outcomes, Scotland Act**

Figure 3 Timeline of major UK and EU legislation pertaining to marine planning [MCAA: UK Marine and Coastal Access Act (2009); SPP: Scottish Planning Policy (2010; 2014); Marine Scotland Act (2010); MPS: UK Marine Policy Statement (2011); NPF3: Scottish National Planning Framework (2014b); MANI: Marine Act Northern Island (2013); SNMP: Scotland's National Marine Plan (MS, 2015); SES: Scotland's Economic Strategy (2015c); other relevant regulations: MSR: UK Marine Strategy Regulations (2010), i.e. MSFD transposed within UK law' National Planning Policy Framework, NPPF (applies for England) (2012)]

Marine Plans are developed and adopted in accordance with the provisions of the UK Marine Policy Statement (MPS) (2011) (HM Government, 2010a; HM Government, 2011); the UK MCAA (2009); MSA (Scotland) (2010) and other relevant legislation[5]. Marine Plans also take into account existing planning regimes for major infrastructure projects (e.g. offshore renewables) and the terrestrial environment.

Scotland

The MSA (Scottish Government, 2010) Marine Scotland (MS) as the statutory institution for delivering marine functions such as planning, licensing (e.g. fishing boats), conservation and the enforcement of marine legislation. Other regulators include the Scottish Environmental Protection Agency (SEPA), and Scottish Natural Heritage (SNH). The Statutory consultees for Sustainability Appraisal (SA) are the SNH, SEPA, Historic Scotland and JNCC (Joint Nature Conservation Committee). The Statutory Consultee for Habitats Regulation Appraisal (HRA) is Scottish Natural Heritage (SNH). Port and Harbour Authorities have a wide range of statutory powers or duties providing considerable autonomy over their area of jurisdiction. Other institutions with regulatory and/or advisory role in ma-

5 For instance, the Marine Strategy Regulations (HM Government, 2010b), transposing into national law the provisions of the Marine Strategy Framework Directive (MSFD). Although not directly regulating maritime activities and marine spatial planning, the particular regulation does impact marine activities and planning by requiring the UK to achieve good environmental status (GES) by 2020.

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rine matters in Scotland include Government departments; Inshore Fisheries Groups (IFGs); National Park Authorities; and the Maritime and Coastguard Agency.

Marine matters in Scotland's inshore waters (<12 nm) are governed by the Marine (Scotland) Act 2010 (Scottish Government, 2010), and in its offshore waters (12-200 nm) by the (UK) Marine and Coastal Access Act 2009 (HM Government, 2009). Scottish waters are managed according to Scotland's (National) Marine Plan (NMP) (Marine Scotland, 2015a) [consistent with the MPS (2011) and the specifications of 2014/89/EU Directive]. The Plan sets national economic, social, climate change mitigation and adaptation, and marine ecosystem objectives. The Plan further integrates existing requirements in relation to international and European legislation. Marine planning will be implemented at a local level, within Scottish Marine Regions (extending ~12 nm).

Scotland's Marine Plan stipulates a core set of General Policies, applicable to all development, use, plan- and decision-making in the marine environment. These General Policies represent the balance required between social, economic and environmental considerations and provide the overarching framework for all activity in the marine environment. Sectoral policies have been developed to address issues beyond the scope of the General Policies, relevant to a particular sector (e.g. aquaculture). These policies have been derived by considering issues which require varying degrees of management to support economically productive activity; manage interaction with other users; respect environmental limits; and to consider climate change.

A total of 11 Marine Planning Regions are designated in The Scottish Marine Regions Order 2015 (Scottish Statutory Instrument No. 193/2015) (Marine Scotland, 2015b). Regional plans will be developed by 'Marine Planning Partnerships', the form and function of which will be consistent with Scotland's NMP and the MPS. Partnerships will differ among regions, to account for local social and environmental conditions. Each Partnership should be representative and engage the full range of stakeholders and interests, but of a size that facilitates decision-making. The involvement of Local Authorities will be important and inshore fishing interests should be represented by Inshore Fisheries Groups (IFG) (whose management plans will inform and reflect the regional plan). Regional Plans will undergo the required SA/SEA, HRA and associated consultation processes. Marine Planning Partnerships, the first of which is in the Clyde and Shetland Isles regions, are to be established, and Regional Plans are currently in development (e.g. Shetland Isles Marine Planning Partnership).

In Scotland, Marine Planning Partnerships will be led by Local Authorities. In 2016, with the Scotland Act, Crown Estates duties in Scotland were transferred to a newly formed public entity, The Crown Estate Scotland. There also exist several non-statutory stakeholders, including private sector and civic society groups that have active engagement in marine planning. As such, their roles, objectives, and activities can frame Marine Plans, the future integration of marine activities and in turn MU. Examples of such stakeholders include the Offshore Renewable Joint Industry Programmes ("ORJIPs"); the EU Ocean Energy Forum (Ocean Energy Forum, 2016); the Royal Society for the Protection of Birds ("RSPB") in the case of Regional Advisory Groups ("RAGs") for Marine Conservation Zones ("MCS"), etc. Regional marine planning powers will be delegated to the Partnerships by Scottish Ministers, although licensing or consenting powers will remain Marine Scotland and Local Authorities. Marine Scotland will support the Partnerships by giving access to research and science, provision and hosting of data through National Marine Plan interactive ("NMPi"), and guidance on policy development.

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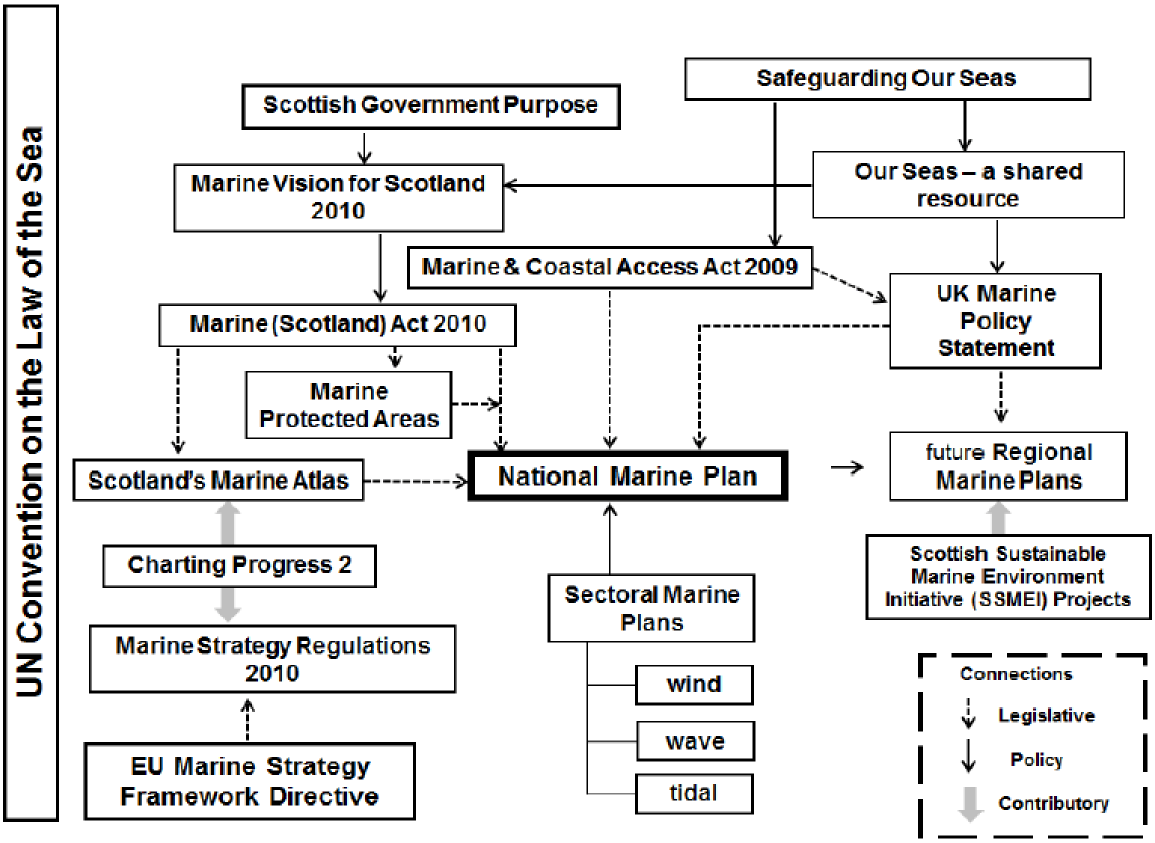

Figure 4 Scottish legislative and policy framework for marine planning (source: Marine Scotland, 2013a)

Marine Scotland, Orkney Islands Council and Highland Council have developed a pilot Pentland Firth and Orkney Firth Marine Spatial Plan. The Plan developed a planning policy framework prior to the development of statutory regional plans (the planning area combines the NMP marine regions of Orkney and the North coast), with the overarching aim of guiding marine development in a sustainable manner (Marine Scotland, 2016). The planning process started in 2011 and received ministerial approval in 2016.

A draft sectoral Marine plan for offshore renewable energy has also been developed (Marine Scotland, 2013b). The draft Plan's mains objectives included: (i) maximizing contribution of offshore renewable energy to renewable energy generation in Scotland; (ii) maximizing opportunities for economic development, investment and employment; and (iii) minimizing adverse effects on people, other sectors and the environment (MS, 2013b). Six offshore renewable regions (SORERs) are set out by the draft Plan (see Appendix 2). In these Regions, draft Plan 'options' were proposed as potential sustainable locations for the development of commercial scale offshore renewable energy development in Scottish Waters. Following consultation, 8 offshore wind, 8 wave and 10 tidal options were included in the Scottish NMP (MS, 2015a).

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Considerable progress in research on maritime spatial planning (MSP) exists at a Scottish level, from relevant projects (Table 1) whose results can contribute to the development of the Regional Plans, aided by key stakeholders. Particularly relevant are the FLOWW; SpORRAn; and NorthSEE projects that contributed in the development of concrete frameworks for MSP of the respective sectors/activities they investigated.

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Table 1 Relevant projects

PROJECT TITLE	Shellfish Aquaculture in Welsh Offshore Wind farms – Co-location Potential	Fishing Liaison With Offshore Wind and Wet Renewables (FLOWW) - Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison	Celtic Seas Partnership – 'Encouraging harmonious co-existence of marine renewables projects with other marine users and interests'	AQUASPACE – Making space for increased aquaculture production	Scottish Offshore Renewables Research framework (SpORRAn)	SIMCELT - Supporting Implementation of Maritime Spatial Planning in the Celtic Seas	CEFOWW – Clean energy from ocean waves	MARIBE - Marine Investment for the Blue Economy
Leader and involved actors	Shellfish association of Great Britain	The Crown Estate (Scotland) (co-ord.), FLOWW Group (fishing industry, offshore renewable developers and consultants, government agencies, Crown Estate)	WF-UK (lead); Univ. of Liverpool, Eastern and Midland Regional Assembly, Natural Environment Research Council, SeaWeb Europe	22 partners : SAMS (co-ord.), AFBI, AZTI-Tecnalia, Bluefarm, CMR, CSIC, FAO, NARIC, IFREMER, IMR, JHI, LLE, Marine Scotland, OC Portugal, TI-SF, UCC, UoC, BHG, NOAA, Dalhousie University, YSFRI, UWA)	Stakeholder co-op. High level co-ordination group (SCG) and seven specialized research groups (SSRG). Including representation from industry, environmental stakeholders, Statutory Nature Conservation Bodies and researchers.	Partners from France, Ireland and the UK. Agence Francaise pour la Biodiversité (AFB), Marine Renewable Energy Ireland (MaREI) Centre, Irish Marine Institute, Marine Scotland, SHOM, University of Liverpool, DAERA.	Fortum (leader), Wello, EMEC (Bilia Croo), Green Marine, Plymouth University, University of Exeter, Uppsala University	11 partners from Ireland, United Kingdom, Belgium, Spain, Italy, Malta and the Netherlands, co-ordinated by University College Cork (MaREI)

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Type of project (public/ commercial/research)	Welsh European Fisheries Fund	Stakeholder co-op. initiative	EU LIFE + project (no.: LIFE11/ENV/UK/392)	H2020	Stakeholder co-op	EU Directorate General for Maritime Affairs and Fisheries	H2020	H2020
Start	2012	2002 (set up of FOWW); 2007: Onset of guidelines development	2013	2015		2015	2015	2015
End	2013	(Ongoing) 2014: Report published	2017	2018	Ongoing	2017	2020	2016
Aim	Develop a pathway encouraging the cultivation of shellfish in Welsh OW Farms. Involves desk-research and the development of links between stakeholders	Enable and facilitate discussion on matters arising from the interaction of the fishing and offshore renewable energy industries; promote and share best practice; and encourage liaison with other sectors	Building relationships and trust; guidance for better management; recognising the value for the marine environment; data access and sharing	Provide increased space of high water quality for aquaculture by adopting the EAA using MSP to deliver food security and increased employment opportunities through economic gr	Support collaborative and coordinated environmental and socio-economic research to facilitate the sustainable development of the Offshore Renewable sector in Scotland.	Support cooperation between Member States on the implementation of the Maritime Spatial Planning Directive in the Celtic Seas.	Deploy advanced multiple wave energy converters (WECs) with improved power generation capability and demonstrate that they are able to survive challenging sea conditions over a period of several years.	Contribute overcoming a series of technological and non-technological challenges and assessment of the most promising and sustainable business models.
MU combination/ resources used	Shellfish aquaculture with OW Farms	-	Review of different case studies	Aquaculture, tourism, fishing, conservation	-			

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Scope	Research – Wales, NE Atlantic		Research - NE Atlantic	Global / EU	Scotland		Research – Innovation action	European Seas
Demonstration/pilot activities	Case-study: North Hoyle OW Farm		-	-			Wave energy	
Location	Wales		Celtic Seas	Case study: Argyll, Scotland;			EMEC Facilities	

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3.2 Relevant MU combination(s) in place and / or potential

Various MU combinations, both existing and proposed, were identified by desk analysis and stakeholder interviews as summarised in Table 2.

Table 2 Relevant MU combinations in study area (existing and proposed). LEGEND: Green -Existing MU; Yellow - MU suggested by stakeholders. Number in brackets - number of interviewees who suggested the MU

MU	Notes
WAVE & AQUAC	Mingary Bay, Albatern WaveNet array connected to Marine Harvest fish-farm feed barge. Commercial development (n= 7)
OW AND WAVE AND AQUACULTURE	(n=4)
OW & WAVE	(n=2)
OW & AQUAC	(n=6)
SHIP TERM & OW	(n=7)

3.2.1 Existing MUs

Wave and aquaculture

The MU has already been implemented (commercial use) in Mingary bay Scotland and links exist between stakeholders to promote further development (see Figure 5). Locations for further MU development are sheltered locations of appropriate wave energy resources, where co-location would be advantageous for both developers (for easy and profitable distribution and selling of produced energy, access to the main electrical grid, energy provision, and economies of scale). Results from stakeholder interviews also suggest the further development of the MU.

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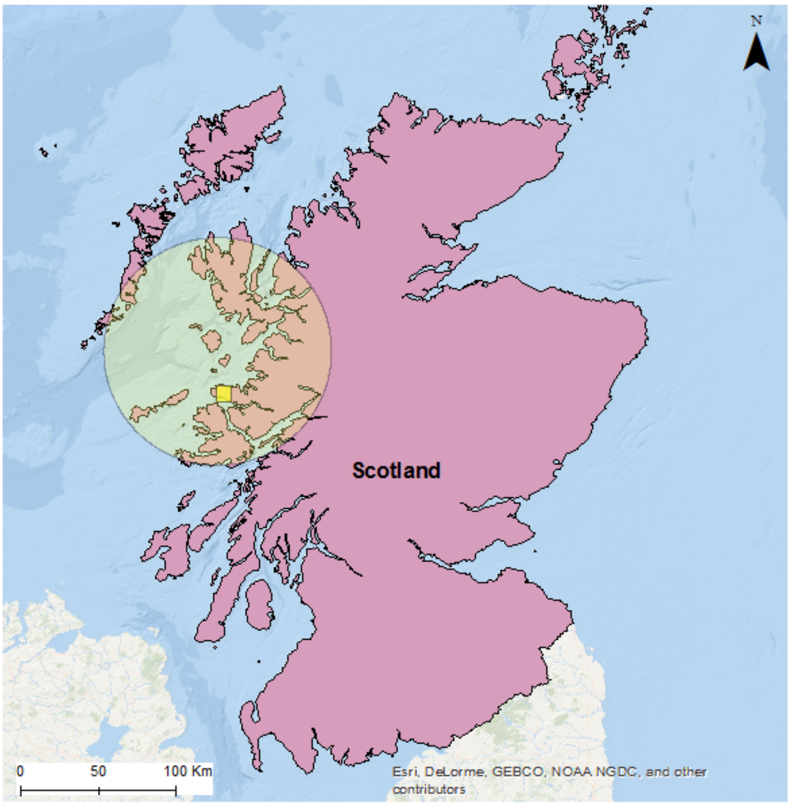

Figure 5 Location of existing MU in study area (circle). Rectangle corresponds to relative location of MU wave and aquaculture in Mingary Bay, West Scotland (Primary data and base-maps after: UKHO, 2014; Marine Scotland, 2017; EUROSTAT, 2017).

3.2.2 Suggested MUs

MU shipping terminal and green energy generation

No actual example of the MU exists in the case study area, either trial or commercial, but future mid- to long-term development is possible. The MU involves the generation of green energy from marine renewable sources (wind, wave, and tide), its transmission to a port substation and the potential of energy being used to cover the energy requirements of the port. The potential of the energy used to power auxiliary engines of berthed vessels (shore side electricity (SSE)) was also investigated.

Offshore wind, wave and aquaculture (including Offshore wind and 'Offshore' aquaculture, Wave and 'Offshore' aquaculture)

Locations in the vicinity are suitable for the further development of aquaculture according to the provisions of the Scottish National Marine Plan (MS, 2015a) (category 3 areas) (Figure 6), provided development is in line with environmental protection and does not obstruct other users, most notably shipping and inshore fisheries. The policy framework already promotes the expansion of aquaculture in further, 'offshore' sites (Scottish NMP, article 7.27, MS, 2015a), which in conjunction with fu-

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ture marine renewable development in the area provides the opportunity of aquaculture being further combined with OW and wave (Figure 6). Past trials of the MU in other locations in the west coasts in the UK (North Hoyle, Liverpool Bay, Wales) were successful and further development could take place in future OWF development in Scotland (West SORER, MS, 2013), as also suggested during our study.

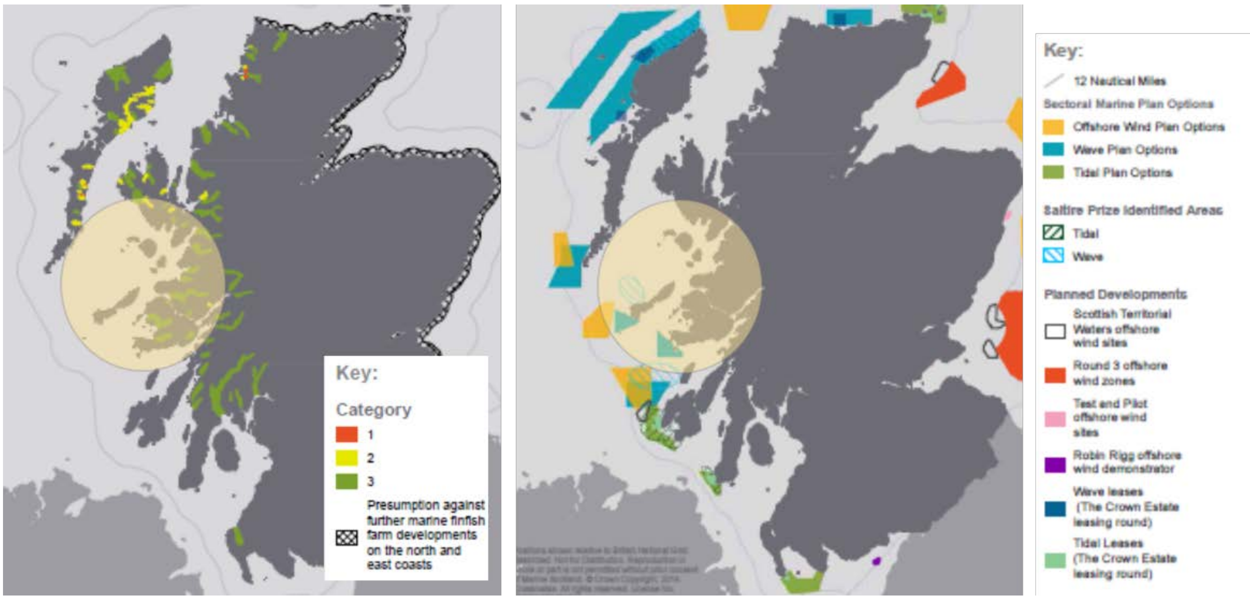

Figure 6 Locations of planned and potential development of the coastal/marine environment in the vicinity of the case study. Left side panel shows locations for the development of fish aquaculture farms (green), Right side panel shows planned OW, wave, tide energy developments [Source: Scottish NMP, MS, 2015a].

3.2.3 Other MUs that were discussed but not considered viable for development in foreseeable future

Tide and aquaculture

Participants thought the tidal conditions required for tidal energy are not currently appropriate for cultivating finfish. However, a significant number of stakeholders, mainly licensors, indicated that it is an MU with potential for the distant future.

Wave energy and coastal protection (breakwater)

Participants mentioned the case of the Siadar Wave energy project (Wavegen and RWE), Isle of Lewis, Outer Hebrides, Scotland. Although the project received governmental approval it has not been implemented due to financial and technological limitations (one of the developers left the project and there were technical issues with the transmission cable).

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Offshore wind and fisheries; Offshore wind and environmental protection; Aquaculture and wild fisheries

Participants who mentioned these combinations did so in the context of the two activities not being able to be dynamically co-located, spatially and temporally: despite the fact that this MU is presumably enabled by the policy context (negative perception). Essentially, the stakeholders showed a negative perception towards these MUs. Notably, in the few instances where MUs were described as existing, activities involved geographical overlap and no dynamic co-location i.e. mutual or synergistic benefit at the core of the relationship.

The MU combinations that were finally selected for further elaboration and analysis in this report include:

- Wave and aquaculture (existing and potential for further expansion); and
- Shipping terminal and green energy generation

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4 CATALOGUE OF MU DRIVERS, BARRIERS, ADDED VALUE, IMPACTS (DABI)

In this section the catalogue of drivers, barriers, added values and impacts (DABI) for the selected MU combinations, as established during desk-study and stakeholders' interviews are presented. Major categories of factors promoting MUs ('drivers') include: policy drivers (e.g. promotion of co-location in key documents); interactions with other users (i.e. integration with existing user); economic drivers (e.g. funds for MU); societal drivers; research drivers (e.g. past projects on MU); and environmental/ resource drivers (i.e. suitability of natural environment). Major categories of factors hindering MUs ('barriers') include: legal barriers; administrative barriers; economic/financial barriers; barriers related with technical capacity (e.g. technology limitations); barriers related to social factors; and barriers related to environmental factors. Major categories of positive effects from MUS ('added values') include: economic; societal; environmental; better insurance policy and risk; and technical added value. Major categories of negative effects from MUS ('impacts') include: economic; societal; environmental; and policy impacts. For the complete list of DABIs see Table 3, Table 4, Table 5 and Table 6.

A more extensive description of the main DABIs is given in the next chapter.

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Table 3 Catalogue of Drivers and Barriers clustered in categories (MU: Wave and Aquaculture).

DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.1 – policy drivers D.1.1. Promotion of co-location (incl. wave and aquaculture.) in Marine Plans, esp. for rural areas (incl. Outer Hebrides, Wales) (MS, 2015; NPF3, Welsh Government). D.1.2. Promotion of marine renewable energy in national / sub-national policies (MS NMP, 2015; NPF3, Welsh Government). D.1.3. Sectoral plans on marine renewable development (ORJIPs, OREDPs, Ocean Energy strategic roadmap). D.1.4. National policy target for doubling aquaculture production. D.1.5. Joint ministerial statement for aquaculture development (Scottish Gov., 2017) and 'multi-annual plan' promoting co-existence. D.1.6. Strategic plan vision for aquaculture (jobs and benefits). D.1.7. Licensors/leasing authorities now strongly considering co-location. D.1.8. Social license from being "Green". D.1.9. Binding Govt. targets on renewable energy and carbon emissions.	***Category B.1 – legal barriers*** B.1.1. Scottish NMP (MS, 2015) 'presumption against further finfish aquaculture. in N.E coast'. B.1.2. Not always possible to co-locate activities under current leasing scheme of the Crown Estate (unless 'demo zones'). B.1.3. Environmental, conservation regulations to be considered. B.1.4. Absence of clear marine planning requirements and supplementary guidance that specifically integrate MUs. B.1.5. Brexit uncertainties over regulatory frameworks, financing and targets.
Category D.2 – interactions with other uses D.2.1. From Marine renewable sector viewpoint, co-location could contribute to reducing project costs across different users (pre-development) D.2.2. Activities taking place in same seabed area, i.e. requiring less space/seabed, esp. as space becomes progressively limited D.2.3. Already existing aquaculture infrastructure (e.g. transport boats) facilitated the Wave Energy operations	***Category B.2 – administrative barriers*** B.2.1. Slow, complicated, demanding EIA & consenting regimes may hinder MU developers. B.2.2. Regulator's rigid interpretation of the law and MU could prevent co-location with non-anthropogenic uses. B.2.3. Licensors/leasing authorities haven't considered a lease for MU; Usually, single, sectoral activity either aquaculture. or energy; i.e. separate applications B.2.4. If MU staggered, may require change in location, editing existing framework/plan (more risks and complications). B.2.5. SEPA "reported" as not supporting large scale operations, needed for profitability in a more globally competitive market. B.2.6. Regulating authorities not knowledgeable of the MU sector in great detail.

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DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.3 – economic drivers	***Category B.3 – economic, financial barriers / risks***
D.3.1. Funding schemes to promote marine renewables esp. in rural areas (EU ESF, RDF; Innovate UK etc.).	B.3.1. Developers (wave, aquaculture.) not currently integrated at a level that supports adequate / detailed co-operation for MU; more an issue of a 'gentleman's agreement' between developers.
D.3.2. Co-location reduces operational, investment and maintenance costs (post-development).	B.3.2. Lack of a definitive brand or market niche for products from MU operations (recognisable brand).
D.3.3. Opportunity to supply numerous island populations that are off-grid; Remote areas could comprise new sites for aquaculture. (shellfish) and be a driver for MU; Likewise, marine renewables could benefit off-grid communities.	B.3.3. Close-containment aquaculture systems may be competing alternatives to the MU in the future.
D.3.4. Savings on energy costs for Aquaculture.	B.3.4. Competition from lower levelised costs of non-renewable carbon-based energy sources.
D.3.5. Showcasing successful MU - developers working together.	B.3.5. Unclear who funds the support / auxiliary infrastructure required for MU (e.g. cable connection).
D.3.6. Potential profits in international and local RE markets.	B.3.6. Commercial viability of MU development, a key evaluation criterion from leasing / licensing / financing perspectives.
D.3.7. Availability of seed capital.	B.3.7. From the perspective of energy developer there needs to exist adequate and reliable demand for produced energy.
D.3.8. Falling unit costs of RE (more competitive with alternative energies).	B.3.8. Inadequate integrated planning / coordination between MU sectors (long-term business plans not effectively linked).
	B.3.9. Lost profit (and fish) in case of technology failure.
	B.3.10. Inequality in financial size and interests - power imbalances between developers.
	B.3.11. Risks of MU viability unclear to potential financers.

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DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.4 – societal drivers D.4.1. Co-location could be a way for 'little guy' (i.e. small-scale developers) to be enter economic value chain in larger numbers D.4.2. Being seen as "Green" enhances social acceptance.	***Category B.4 – barriers related to technical capacity*** B.4.1. Wave energy requires specific wave and climate conditions, which may not be optimal for aquaculture. B.4.2. MU involves two very dissimilar activities to easily come together and apply as a single activity or use. B.4.3. Wave technology limitations, i.e. still in early stages of commercial development. B.4.4. Energy demands and supply of developers might not match. B.4.5. Frustrated access to main grid arising from challenges with storage and transmission of produced energy. B.4.6. Lack of successful demonstrations on operation and viability of MU.
Category D.5 - Research drivers D.5.1. Insight from past research projects (MARIBE). D.5.2. Marine renewable developers progressively more engaged in research projects (MARIBE, Aquatera and Columbus project). D.5.3. Research in sea lice treatment and new farmed species (e.g. Scottish Aquaculture Innovation Centre (SAIC)). D.5.4. Considerable research on site suitability for marine renewables.	***Category B.5 – barriers related to social factors*** B.5.1. Commercial fisheries and auxiliary businesses may contest planning sites due to potential impacts on wild salmons B.5.2. Local communities, anglers may contest planning sites due to potential impacts on wild salmons. B.5.3. Other tenants may prevent the MU development.
Category D.6 – Environmental / Resource drivers D.6.1. Substantial availability of wave resources (esp. NW UK). D.6.2. Space/location availability for aquaculture sector (and further expansion if needed). D.6.3. Mussels long-lines could act as barrier to very dynamic wave/tidal environment (shelter effect). D.6.4. MU was in proximity to land, facilitating maintenance and service. D.6.5. Off-grid diesel generators replaceable by Wave energy. D.6.6. Climate change effects (decrease in wild salmon stocks) leading to promotion of aquaculture; and need to reduce effects of bycatch in wild fisheries. D.6.7. Sheltered sites for Wave technology.	***Category B.6 – barriers related to environmental factors*** B.6.1. MU requires specific optimal conditions e.g. natural environment limits optimal aquaculture locations and type of species to be farmed B.6.2. Sea lice impacts on aquaculture. B.6.3. Ground conditions / physical seabed may be challenging for successful MU operations.

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Table 4 Catalogue of Added Values and Impacts clustered in categories (MU: Wave and Aquaculture)

ADDED VALUES = positive effects of MU	**IMPACTS** = negative effects of MU
Category V.1 – economic added value V.1.1. Showcase and demonstration of proof for MU concept and benefits. V.1.2. Conservation costs for sites can be shared. V.1.3. Green credentials leveraged for funding. V.1.4. Savings from labour crossover. V.1.5. Income from feed in tariffs.	***Category I.1 – economic impacts*** I.1.1. Local boat operators supplying diesel generators to Fish farms lose jobs as energy supplied by wave operator.
Category V.2 – societal added value V.2.1. Developer and aquaculture. Clusters did considerable community engagement actions (Scottish Salmon Producer's organisation) 'Community charter'. V.2.2. MU would facilitate connectivity for isolated off-grid coastal communities via scaled down micro renewables. V.2.3. Community, education and employment opportunities. V.2.4. Local communities could also be 'developers' within the context of Marine Planning Partnerships. V.2.5. Green credentials of MU enhance social acceptance; won EU Green award. V.2.6. Green energy supplied to local communities.	***Category I.2 – societal impacts*** I.2.1. Navigation, other users, traffic, constrained by new MU. I.2.2. Reduced income to local economy from lost jobs from boats which will no longer be used.
Category V.3 – environmental added value V.3.1. MU could facilitate mitigation of adverse environmental impacts from both developers. V.3.2. Reduction of CO_2 emissions (overall reduced carbon footprint from both developers). V.3.3. Small sea surface area footprint 40m X 40m for Wave Energy operation.	***Category I.3 – environmental impacts*** I.3.1. Uncertainty about impacts is a challenge for industry regulators and advisors (TCE, 2015). I.3.2. Noise impacts and collision risks of marine mammals with wave energy devices or vessels. I.3.3. Biofouling and escapees from aquaculture; impacts on wild populations (progeny that doesn't survive in habitats). I.3.4. Pollution risk from hydraulic fluid leakage.

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ADDED VALUES = positive effects of MU	**IMPACTS** = negative effects of MU
Category V.4 – better insurance policies and risk management V.4.1. EIA for first use facilitated EIA for second use. V.4.2. Proof of concept for future upscaling; reduces project and investment risks. V.4.3. Although MU may complicate licensing process; it may result in mitigation of negative impacts and simplify associated EIA process. V.4.4. Consenting / licensing approach of "deploy and monitor" instead of rigid “precautionary principle”. V.4.5. Confluence of appropriate requisite strategic / optimal factors coming together to support MU.	***Category I.5 - policy impacts*** I.5.1. MU activities could further complicate licensing process, EIA etc. I.5.2. MUs discouraged by Government inconsistency and unpredictability in long-term targets and supporting policies especially for marine Renewable Energy.
Category V.5 - technical added values V.5.1. Wave operator shared infrastructure from Aqua. Operator. V.5.2. Modular space frame technology: flexible, scalable, less space V.5.3. Consenting authority "one stop shop". V.5.4. Protected bay offers safety assurance for WE technology.	

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Table 5 Catalogue of Drivers and Barriers clustered in categories (MU: Shipping Terminal and Marine Renewable Energy)

DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.1 – policy drivers D.1.1. MARPOL Annex VI and Global Shipping Industry set targets for reducing CO_2 emissions / air pollution D.1.2. EU / national/ sectoral legislation / institutional desire to reduce greenhouse gas emissions and meet upcoming air pollution requirements sulphur content of marine fuels; D.1.3. Policy for investment in offshore marine renewables (Wales and Scotland NMP; Ocean Energy Strat. Roadmap) D.1.4. World Port Climate Initiative (WPCI) by many ports to reduce greenhouse gases, ships to reduce port-related emissions D.1.5. Ownership status of port (usually public, for major industrial EU ports, e.g. Hamburg, Rotterdam, Antwerp) D.1.6. Government financial support for public, trust ports D.1.7. Paris Convention for climate change D.1.8. Sub-national marine plans (e.g. Welsh) promote redevelopment for disused ports	***Category B.1 – legal barriers*** B.1.1. No IMO leg. B.1.2. Ownership status of port in private control B.1.3. Crown estate owns Offshore locations but not port - complicates licensing
Category D.2 – interactions with other uses D.2.1. Grid connection of ports can facilitate OW connection. D.2.2. Existing Onshore renewables on ports D.2.3. Ports as accommodation for OWF, O&G sector	***Category B.2 – administrative barriers*** B.2.1. Environment plans for ports mainly focused on contamination, dredging, not Climate Change or carbon emissions. B.2.2. Staff of environmental authorities mainly interested in legal compliance not novel Shore Side Electricity solutions. B.2.3. EU-level centralised facilitation process is needed e.g. to standardise / universalise port SSE facilities but does not yet exist. B.2.4. If MU development infrastructure will require lease of seabed from Crown Estate, may present complicated legislative process: current leasing system does not know how to address two activities as MU. B.2.5. Absence of guidelines on how to invest in renewables connected to port level / shipping terminal activities.

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DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.3 – economic drivers D.3.1. Financial incentives provided to vessels who take up SSE in key ports (e.g. Antwerp). D.3.2. Investment of major companies in renewable energy (e.g. Nissan). D.3.3. Main Ports and shipping sectors leaders indicated intentions to reduce fuel consumption, carbon emissions. D.3.4. Feed in tariffs provided to ports for investing in renewable energy projects, incl. SSE. D.3.5. Competent seabed authorities understand advantage of closer co-operation with port authorities. D.3.6. Renewable energy developer profit incentive from selling electricity generated.	***Category B.3 – economic, financial barriers / risks*** B.3.1. Private owners of ports not willing to co-locate B.3.2. Port dependent on O&G cannot readily diversify B.3.3. Solar, land-based solutions, LNG championed and already ahead of marine MUs. B.3.4. Onshore wind cheaper / more competitive. B.3.5. Huge investments to convert vessels to SSE compatible; universal standards needed. B.3.6. Other sources including non-renewables, more viable and cost effective (e.g. LNG) and already championed. B.3.7. Route of vessel, level of activity limits ability to take up SSE. B.3.8. No funds yet dedicated specifically to such MU activity B.3.9. Uncertainty - Large drop in Feed In Tariffs for renewable energy; no other subsidies available; led to changes in power provision scheme with port. B.3.10. Competition with other (also non-EU countries) ports; vessels will shift activity there. B.3.11. Unclear who is to underwrite and fund auxiliary infrastructure e.g. cable and transmission system, access to grid.
Category D.4 – societal drivers D.4.1. Socio-political awareness and market for “green” energy. D.4.2. City council / developers partnerships acting as actors.	***Category B.4 – barriers related to technical capacity*** B.4.1. Scale of port, type vessels accommodated. B.4.2. OW energy transmission and storage in port. B.4.3. Huge energy requirements to fuel vessels. B.4.4. Renewables energy fluctuations - unsteady supply B.4.5. Class and size of vessels (e.g. cruise ships) too expensive to convert engine. B.4.6. Type of vessels - not possible to convert some to SSE (e.g. tankers, cargo). B.4.7. Position of vessel relative to port / Space of port. B.4.8. Infrastructure of port to implement SSE. B.4.9. No net gain anticipated for SSE investment in the short term.

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DRIVERS = factors promoting MU	**BARRIERS** = factors hindering MU
Category D.5 - Research drivers D.5.1. OW could be used to provide SSE D.5.2. Certain locations with experience in investments in onshore renewables (solar, wind) D.5.3. Conversion to SSE could be an asset for certain class / category of vessels (e.g. pilot boats, fishing vessels, survey/accommodation vessels for OWF) D.5.4. Research / technology progress in OW & proximity to coast	***Category B.5 – barriers related to social factors*** B.5.1. Local residents, communities may object relevant developments ['Not-in-my-back-yard' attitude (NIMBYism)] B.5.2. Shipping lanes, commercial port traffic may constrain recreational uses. B.5.3. Visual impacts of OWF B.5.4 Impacts on fisheries from OWF
Category D.6 – Environmental / Resource drivers D.6.1. Strategic / nodal location of ports as part of energy hub / connection with grid	***Category B.6 – barriers related to environmental factors*** B.6.1. Depth of port B.6.2. Sheltered port environment may constrain available wind/wave/tidal energy B.6.3. Wind fluctuation B.6.4 Corrosion - salt-water environment

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Table 6 Catalogue of Added Values and Impacts clustered in categories (MU: Shipping Terminal and Marine Renewable Energy)

ADDED VALUES = positive effects of MU	**IMPACTS** = negative effects of MU
Category V.1 – economic added value V.1.1. Ports could serve as part of infrastructure for OW, saving related costs V.1.2. Value chain around supplying activities at shipping terminal with energy is diversified to local players / geography. V.1.3. Decline in costs for offsetting fossil fuels-related carbon emissions.	***Category I.1 – economic impacts***
Category V.2 – societal added value V.2.1. New employment opportunities. V.2.2. Community engagement, education, public outreach by investment in green / renewable energy. V.2.3. For highly industrial ports, OW and shipping industry will have small visual impact and may be perceived positively by residents. V.2.4. Equity and prestige of branding as “eco-port” (British Port Association) in case of differentiation via MU.	***Category I.2 – societal impacts*** I.2.1. Navigation, shipping lanes can be constrained by MU. I.2.2. ‘NIMBYism’ and objections from visual impacts. I.2.3 Activities e.g. sailing, recreation can be constrained. I.2.4 May constrain areas for fisheries.
Category V.3 – environmental added value V.3.1. Reductions in GHGs as shipping terminals tend to be emission hotspots.	***Category I.3 – environmental impacts*** I.3.1. Noise and impacts on marine mammals during construction. I.3.2. Noise and impacts on birds from OWF (close to land).
Category V.4 – better insurance policies and risk management V.4.1. Developers anticipate legislation to become progressively stricter in requiring reductions in GHG emissions.	***Category I.5 - policy impacts***
Category V.5 - technical added values V.5.1. Potential proof of concept and handling upon which more effective and cheaper global scale solutions can be based.	

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5 RESULTS OF DABI SCORING: ANALYSIS OF MU POTENTIAL AND MU EFFECT

Analysis of the list of categories of factors (Table 7) was undertaken focusing on those factors that had a score above 2.0, as a practical threshold for factors that have been scored as significant.

Of the drivers, a notable majority of factors at 38.4% came from Policy category, with Economic and Physical Environment / Resources categories contributing a lower proportion of 23.1% each. The category Interaction with Other Users contributed the least proportion at 15.3%. Policy, Physical Resources and Economics categories of factors had the strongest average score (3), followed by Interactions with Other Users at 2.75. Of the barriers, a similarly notable majority of 37.5% came from Economic factors; with Legal, Administration, Technical and Environmental factors contributing a much lower proportion of 14.3% each, respectively. The Societal factors contributed the least proportion at 7.1%.

From the list of barriers (Table 7), those that can be classified as “real”, i.e. requiring long -term actions to remove / overcome, comprise only 14.2 % in proportion, and include:

- Commercial viability of MU development, a key evaluation criterion from leasing / licensing / financing perspectives.
- MU involves two very dissimilar activities to easily come together and apply as a single MU.

From Table 7 those barriers that are classified as “perceived” comprise 71.4% and include:

- Scottish NMP (MS, 2015a) 'presumption against further finfish aquaculture. in N.E coast'.
- Not always possible to co-locate activities under current leasing scheme of the Crown Estate (unless 'demo zones').
- Slow, complicated, demanding EIA & consenting regimes may hinder MU developers.
- SEPA “reported” as not supporting large scale operations, needed for profitability in a more globally competitive market.
- From the perspective of energy developer there needs to exist adequate and reliable demand for produced energy.
- Energy demands and supply of developers might not match.
- Other tenants / users may prevent the MU development.
- Developers (wave, aquaculture.) not currently integrated at a level that supports adequate / detailed co-operation for MU; more an issue of a 'gentleman's agreement' between developers.
- Lack of a definitive brand or market niche for sp. cultured within MU operations (perhaps recognisable quality mark).
- Competition from lower levelised costs of non-renewable carbon-based energy sources.
- MU requires specific conditions e.g. natural environment limits optimal aquaculture locations and type of species to be farmed
- Sea lice impacts on aquaculture for aquaculture developer.

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The Societal (3) and Economic (2.94) factors had the strongest average scores, followed by Legal, Administration, Technical and Environmental at 2.75 each, respectively, seemingly all significant barriers according to the scores. We therefore conclude that the cumulative effects of the existing economic and financial risks to full development and deployment of MUs; lack of explicit policy and regulatory requirements promoting MU, creates a prevailing reality that acts as a barrier to MUs: as "financial" risks remain too high for developers.

While the MU potential was marginally positive (see Table 7) at an indicative net score of 0.01, the net MU effect was 8 times in magnitude at 0.08, indicating a positive overall impact of the MU outcomes can be made.

Table 7 Scored Drivers, Barriers, Added values and Impacts for MU Wave energy and aquaculture (starting with factors with highest value)

DRIVERS = factors promoting MU			**BARRIERS** = factors hindering MU		
Factor	**Category**	**Average score**	**Factor**	**Category**	**Average score**
D.1.1	Policy	3	B.1.2	Legal	3
D.1.2	Policy	3	B.2.5	Administrative	3
D.1.4	Policy	3	B.3.2	Economic	3
D.1.5	Policy	3	B.3.7	Economic	3
D.1.9	Policy	3	B.4.2	Technological	3
D.2.1	Interactions with other uses	3	B.5.3	Social	3
D.3.6	Economic	3	B.6.1	Environmental	3
D.3.8	Economic	3	B.3.4	Economic	3
D.6.1	Physical resources	3	B.3.6	Economic	3
D.6.2	Physical resources	3	B.3.1	Economic	2.7
D.6.4	Physical resources	3	B.1.1	Legal	2.5
D.3.3	Economic	2.7	B.2.1	Administrative	2.5
D.2.2	Interactions with other uses	2.5	B.4.4	Technological	2.5
D.1.3	Policy	2	B.6.2	Environmental	2.3
D.1.6	Policy	2	B.3.5	Economic	2
D.1.7	Policy	2	B.3.8	Economic	2
D.3.1	Economic	2	B.1.3	Legal	2
D.3.2	Economic	2	B.1.4	Legal	2
D.3.7	Economic	2	B.2.4	Administrative	2
D.4.1	Societal	2	B.2.6	Administrative	2
D.5.1	Research	2	B.3.3	Economic	2

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DRIVERS = factors promoting MU			BARRIERS = factors hindering MU		
Factor	**Category**	**Average score**	**Factor**	**Category**	**Average score**
D.5.2	Research	2	B.3.9	Economic	2
D.5.3	Research	2	B.4.1	Technological	2
D.5.4	Research	2	B.4.3	Technological	2
D.6.3	Physical resources	2	B.4.5	Technological	2
D.6.5	Physical resources	2	B.4.6	Technological	2
D.7.1	Environmental	2	B.5.1	Social	2
D.3.4	Economic	1.8	B.5.2	Social	2
D.3.5	Economic	1.3	B.3.11	Economic	2
D.1.8	Policy	1	B.2.3	Administrative	1.7
D.2.3	Interactions with other uses	1	B.3.10	Economic	1
D.4.2	Societal	1	B.1.5	Legal	1
D.7.2	Environmental	1	B.2.2	Administrative	1
			B.6.3	Environmental	1
DRIVERS average score		**2.22**	**BARRIERS average score**		**-2.21**
		MU POTENTIAL	**0.01**		

ADDED VALUES = positive effects of MU			IMPACTS = negative effects of MU		
Factor	**Category**	**Average score**	Factor	Category	Average score
V.2.3	Social	2.3	I.5.1	Policy	3
V.3.1	Environmental	2.3	I.5.2	Policy	3
V.3.2	Environmental	2.3	I.3.3	Environmental	2.3
V.1.1	Economic	2	I.3.1	Environmental	2
V.1.5	Economic	2	I.3.2	Environmental	1.5
V.2.1	Social	2	I.1.1	Economic	1
V.2.2	Social	2	I.2.1	Social	1
V.2.4	Social	2	I.2.2	Social	1
V.2.5	Social	2	I.3.4	Environmental	1
V.3.3	Environmental	2			
V.4.1	Risk Management	2			
V.4.2	Risk Management	2			

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ADDED VALUES = positive effects of MU			IMPACTS = negative effects of MU		
Factor	**Category**	**Average score**	Factor	Category	Average score
V.4.3	Risk Management	2			
V.4.4	Risk Management	2			
V.4.5	Risk Management	2			
V.5.2	Technological	2			
V.1.3	Economic	1.5			
V.1.2	Economic	1			
V.1.4	Economic	1			
V.2.6	Social	1			
V.5.1	Technological	1			
V.5.3	Technological	1			
V.5.4	Technological	1			
ADDED VALUES average score		**1.83**	**IMPACTS average score**		**-1.75**
		MU OVERALL EFFECT	**+0.08**		

Analysis of the list of categories of factors (Table 8) was undertaken focusing on those factors that had a score above 2.0, as a practical threshold for factors that have been scored as significant. Of the drivers, a notable majority of factors at 38.8% were in the Policy and 22.2% in the Economic categories, followed by societal (11.1%) and Interactions with Other Uses (11.1%). The fewest contribution of factors was due to Physical/environmental resources (5.56%), Environmental (5.56%) and Research factors (5.56%). Of the long list of barriers, of 36% were technology related, closely followed by Economics-related factors at 32%; with Legal (8%), Social (8%) and Administration (4%) factors contributing a much lower proportion of barriers.

From the list of barriers (Table 8), those that can be classified as “real”, i.e. requiring long -term actions to remove / overcome, comprise only 28 % in proportion, and include:

- Ownership status of port. The development goals and planning objectives of private ports and their harbour authorities may differ from governmental ones (esp. EU, national).
- Onshore wind development may be a more viable alternative for the port developer as development is straight-forward and investment costs are smaller.
- Huge investments required to convert vessels’ engines to SSE compatible; universal standards needed.
- Competition with other (also non-EU countries) ports; vessels will shift activity there.
- OW energy transmission and storage in port.
- Depth of port.

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- Sheltered port environment may constrain available wind/wave/tidal energy.

From Table 8 those barriers that are classified as “perceived” comprise 72% and include:

- If wind energy development is to take place in the marine environment, a seabed lease is required from the Crown Estate, the port is not the proprietor/competent authority (as in the case of onshore developments). This complicates licensing.
- Absence of guidelines on how to invest in renewables connected to port level / shipping terminal activities.
- Private owners of ports may not be willing to co-locate.
- Other sources including non-renewables, more viable and cost effective (e.g. LNG) and already championed.
- No funds yet dedicated specifically to such MU activity.
- Uncertainty - Large drop in Feed In Tariffs for renewable energy; no other subsidies available; led to changes in power provision scheme with port.
- Unclear who is to underwrite and fund auxiliary infrastructure e.g. cable and transmission system, access to grid.
- Scale of port, type vessels accommodated.
- Huge energy requirements to fuel vessels.
- Renewables energy fluctuations - unsteady supply.
- Class and size of vessels (e.g. cruise ships) too expensive to convert engine.
- Type of vessels - not possible to convert some to SSE (e.g. tankers, cargo).
- Position of vessel relative to port / Space of port.
- Infrastructure of port to implement SSE.
- No net gain anticipated for SSE investment in the short term.
- Local residents and communities may object relevant developments - ‘Not-in-my-back-yard’ reaction (‘NIMBYism’).
- Shipping lanes, commercial port traffic may constrain recreational uses.
- Wind fluctuation.

While the MU potential was marginally negative (see Table 8) at an indicative net score of -0.05, the net MU effect was 6 times in magnitude at 0.33, indicating a negative overall impact of the MU outcomes, if the MU is realised.

However on deeper analysis, such a net negative potential and net effect seems to be a result of the relatively high number of “perceived barriers”, which were taken into the account in the calculations.

Table 8 Scored Drivers, Barriers, Added values and Impacts for MU Shipping terminal and Marine Renewable Energy (starting with factors with highest value)

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DRIVERS = factors promoting MU			BARRIERS = factors hindering MU		
Factor	**Category**	**Average score**	**Factor**	**Category**	**Average score**
D.1.1	Policy	3	B.1.3	Legal	3
D.1.2	Policy	3	B.2.5	Administrative	3
D.1.5	Policy	3	B.3.1	Economic	3
D.1.7	Policy	3	B.3.4	Economic	3
D.3.1	Economic	3	B.3.6	Economic	3
D.3.6	Economic	3	B.3.8	Economic	3
D.4.1	Societal	3	B.3.9	Economic	3
D.6.1	Physical resources	3	B.3.10	Economic	3
D.7.1	Environmental	3	B.4.1	Technological	3
D.2.3	Interactions with other uses	2.8	B.4.3	Technological	3
D.1.4	Policy	2.7	B.4.4	Technological	3
D.1.6	Policy	2.7	B.4.5	Technological	3
D.3.4	Economic	2.7	B.4.6	Technological	3
D.4.2	Societal	2.7	B.4.7	Technological	3
D.2.1	Interactions with other uses	2.6	B.4.8	Technological	3
D.3.3	Economic	2.5	B.4.9	Technological	3
D.5.4	Research	2.5	B.5.1	Social	3
D.1.3	Policy	2.3	B.5.2	Social	3
D.2.2	Interactions with other uses	2	B.6.1	Environmental	3
D.3.2	Economic	2	B.1.2	Legal	2.8
D.3.5	Economic	2	B.3.5	Economic	2.5
D.5.3	Research	2	B.3.11	Economic	2.5
D.5.2	Research	1.5	B.4.2	Technological	2.5
D.1.8	Policy	1	B.6.2	Environmental	2.3
D.5.1	Research	1	B.6.3	Environmental	2.3
			B.1.1	Legal	2
			B.2.1	Administrative	2
			B.2.3	Administrative	2
			B.2.4	Administrative	2
			B.3.2	Economic	2
			B.3.7	Economic	2
			B.5.4	Social	2

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DRIVERS = factors promoting MU			BARRIERS = factors hindering MU		
Factor	**Category**	**Average score**	**Factor**	**Category**	**Average score**
			B.6.4	Environmental	2
			B.5.3	Social	1.5
			B.2.2	Administrative	1
			B.3.3	Economic	1
DRIVERS average score		**+2.48**	**BARRIERS average score**		**-2.53**
		MU POTENTIAL	**-0.05**		

ADDED VALUES = positive effects of MU			IMPACTS = negative effects of MU		
Factor	**Category**	**Average score**	Factor	Category	Average score
V.1.3	Economic	3	I.2.2	Social	3
V.3.1	Environmental	3	I.2.4	Social	3
V.5.1	Technological	3	I.3.2	Environmental	3
V.2.1	Social	2.7	I.3.1	Environmental	2.5
V.1.1	Economic	2.3	I.2.1	Social	2.3
V.1.2	Economic	2	I.2.3	Social	2
V.2.2	Social	2			
V.2.4	Social	2			
V.4.1	Risk Management	2			
V.2.3	Social	1			
ADDED VALUES average score		**+2.3**	**IMPACTS average score**		**-2.63**
		MU OVERALL EFFECT	**-0.33**		

Categories of factors that contributed most to the drivers of the MU Wave energy and Aquaculture, according to average scores (Table 9), were Policies (2.6), Interactions with Other Sectors and Economics (2.3), with the least scored categories being Physical Resources (1.5) and Environmental (1.3) categories. In contrast, the most significant category of barriers, according to average scores, were Economic (2.5), Technological (2.3) and Environmental (2.3), with the least scored categories being Legal, Administration and Social, at 2.2 each, respectively.

Table 9 Scored Drivers, Barriers, Added values and Impacts table per category: MU Wave energy and aquaculture

DRIVERS = factors promoting MU	BARRIERS = factors hindering MU

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Category	Average score	Category	Average score
D.1 Policy	2.6	B.3 Economics	2.5
D.2 Interaction with others	2.3	B.4 Technological	2.3
D.3 Economic	2.3	B.6 Environmental	2.3
D.4 Social	2.2	B.1 Legal	2.2
D.5 Research	2	B.2 Administrative	2.2
D.6 Physical resources	1.5	B.5 Social	2.2
D.7 Environmental	1.3		
ADDED VALUES = positive effects of MU		**IMPACTS** = negative effects of MU	
Category	**Average score**	**Category**	**Average score**
V.3 Environmental	2.1	I.5 Policy	3
V.2 Social	2	I.3 Environmental	2.1
V.4 Risk management	2	I.1 Economics	1
V.1 Economic	1.6	I.2 Social	1
V.5 Technological	1.3		
V.3 Environmental	2.1		

Categories of factors that contributed most to the drivers of the MU Shipping terminal and Marine Renewable Energy, according to average scores (Table 10), were Physical environment (3.0), Environmental (3.0) and Economic (2.7), with the least scored categories being Interaction with others (2.5), Policy (2.4) and Technological (2.0) categories. In contrast, the most significant category of barriers, according to average scores, were Technological (3.0), Legal (2.8) and Economic (2.7), with the least scored categories being Social (2.5), Environmental (2.4) and Administration (2.0).

Table 10 part B Scored Drivers, Barriers, Added values and Impacts table per category: MU Shipping terminal and Marine Renewable Energy

DRIVERS = factors promoting MU		**BARRIERS** = factors hindering MU	
Category	**Average score**	**Category**	**Average score**
D.6 Physical environment	3.0	B.4 Technological	3.0
D.7 Environmental	3.0	B.1 Legal	2.8
D.3 Economic	2.7	B.3 Economic	2.7
D.4 Social	2.7	B.5 Social	2.5
D.2 Interaction with others	2.5	B.6 Environmental	2.4

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D.1 Policy	2.4	B.2 Administration	2.0
D.5 Technological	2.0		
ADDED VALUES = positive effects of MU		**IMPACTS** = negative effects of MU	
Category	**Average score**	**Category**	**Average score**
V.3 Environmental	3.0	I.2 Social	2.5
V.5 Technological	3.0	I.3 Environmental	2.5
V.1 Economic	2.3		
V.2 Social	2.2		
V.4 Risk management	2.0		

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6 FOCUS AREAS ANALYSIS

6.1 MU Combination: Wave & Aquaculture

6.1.1 Focus Area 1: Addressing MUs

1) Establishing, widening and strengthening MUs in the case-study area

The abundance of wave energy resource in the western UK and supportive scientific literature and key policy and sectoral documents (Ocean Energy Forum, 2016; Kalogeri et al., 2017; Marine Energy Wales, 2017) indicates that the MU has considerable potential for development in the mid- to long-term. Stakeholders suggest that there exists a large potential for the MU in the western Scottish Isles with the development of salmon and/or mussel farms, in line with the general policy directions for the aquaculture sector.

The MU expansion would accommodate part of the energy requirements of aquaculture developers; supply energy to remote, rural communities with poor connection to the grid; and also provide revenues for the energy developers. As key policy and strategic documents (MS, 2013; Vision 2030 WG, 2016, 2017) suggest economic value of aquaculture would double by 2030 this may be partly supplied within an MU framework. Co-location could also contribute to reducing project development costs (pre-development), while further reducing operational, investment and maintenance costs. The MU would further contribute to meeting the demands for premium Scottish seafood, harvested to high environmental and regulatory standards, for which projections indicate that demand will grow.

At a more societal level, the carbon footprint and carbon emissions from Scotland would be reduced, contributing towards the Paris Agreements and Scottish government target of meeting 100% electrical energy demand from renewable sources. Section 6.1.2 further discusses the societal benefits of the MU to local communities.

2) Space availability for MU development

As key policy and strategic documents for aquaculture (MS, 2013; Vision 2030 WG, 2016, 2017 Joint Ministerial Statement; DEFRA, 2015) suggest economic value to double by 2030, optimal space availability is expected to be a "*major issue*". Some stakeholders have therefore argued that the pressure for optimal spaces will be a positive driver for the MU. It is also argued that this could occur much sooner, spurred on as the multiplier effects of the benefits of MU are realised. Moreover, explicit reference to MUs by policy documents that make them a regulatory requirement, may heighten the scramble for optimal space. The tipping point of when space availability becomes a limiting factor for the MU is unclear. This situation is further dependent on technology developments.

As the type of cultured species (salmon, shellfish) require specific physical and environmental characteristics and determine site selection; this may also put pressure on space available, thus potentially driving the MU. To that end, co-location could be advantageous for both developers. The example of new sites for shellfish aquaculture was mentioned, where mussels' long-lines could act as natural barriers to very dynamic wave and tidal conditions in certain sites.

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There exist clear guidelines for the areas and locations of fish farm development in Scotland (MS, 2015a). There is a presumption against further finfish farm development on the North and east coast to safeguard migratory fish species (MS, 2015a). This limits the potential for the MU in the North Sea where finfish is excluded, and simultaneously adds additional pressure on allowable marine spaces, such as the broader area of the case study. Interviewees mentioned the prospect of the MU to '*go out to the Atlantic*' as also promoted by the current policy context (Scottish NMP, 7.27) (MS, 2015a) ('*expansion in the number of larger, further off-shore sites*') and also working with a number of other sectors, such as offshore wind (OW). However, most of this MU expansion would be near shore as locating in deeper offshore waters may occur mid- to long term, as technological feasibility and viability of scalable MU is yet to be demonstrated.

It should also be noted that competent authorities for the granting of seabed view favourably the fact that in the context of MUs, activities are taking place in the same seabed area, thus less space/seabed is required, especially as marine space is becoming progressively more limited and congested.

3) MU combinations and potentials

In the current case study, the MU was staggered, with fish farming having been there for many years, and Wave Energy only recently joining.

Integrated and coordinated planning will enable balancing the needs of both developers (e.g. energy supply and demand), while also accounting for future expansion of the MU. This would allow scaling up for both users, especially energy developers that could produce energy at a lower cost competitive with alternative sources. Such an approach would significantly reduce most of the barriers identified in the study, whilst enhancing some of the added values from the MU.

The situation where the aquaculture operator goes deeper offshore would significantly increase the opportunity for the wave technology to be a useful significant "partner", through the provision of energy. Moreover, investment risks are spread among partners, whilst environmental impacts from both partners are mitigated (e.g. CO_2 emissions reductions). There exist power imbalances between the MU developers and there is need for a situation where the "bigger partner" considers the value/benefit to be gained from the "smaller partner" within the MU context.

The expansion of the MU to new locations, potentially further offshore, may promote the need for co-existence of the MU with other users such as commercial fishing. Also, with a presumed expansion of OWF in the Atlantic, the MU could be further integrated with OW, with attendant increase in demand and traffic of auxiliary services (aquaculture accommodation vessels).

Stakeholders also mentioned the possibility of aquaculture working with other sectors, and made special reference to the case of disused, decommissioned floating platforms of the Oil and Gas (O&G) sector, that would be particularly advantageous from the perspective of reducing required planning controls. However, they noted that barriers to such a co-operation may arise due to the current regulatory framework (OSPAR, 1992) that is not clear on this possibility.

Further integration of other aquaculture components in the MU could take place in suitable sites in the broader case study area, as suggested by participants and in line with the policy framework for Integrated Multi-trophic Aquaculture (IMTA): "a combination or shellfish (particularly mussels and

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oysters), finfish (salmon, but also other potential fish sp.) and seaweed for a variety of products, such as human food, a gelling and thickening agent, animal feed, and nutraceuticals (food products that provide health and medical benefits) as well as in integrated multi-trophic aquaculture systems, where the by-products from one species are recycled to become inputs for another" (MS, 2015a).

4) Resources to be shared between users

The most important resources to be shared between the MU partners are as follows:

- Physical: water
- Geographic: spatial proximity
- Infrastructure: electricity supply cables in water and on land; landing site for their maintenance boats and staff.
- Services: fisher boats; financial investment as the MU could itself be leveraged as a less risky concern with fewer "socially and environmentally negative" risks.
- Personnel: potential sharing during non-specialised tasks of constructions, operations and maintenance.

5) MU within policy

The potential of co-location of aquaculture with marine renewable energy is suggested by UK's multi-annual national plan for the development of aquaculture (DEFRA, 2015): "*There are possibilities of co-location (with marine energy installations), multi-trophic aquaculture (salmon and shellfish (mussels), new systems and species (e.g. seaweed) and co-operative approaches to share costs and risks*" (DEFRA 2015, pg. 5). Managing multiple-use, co-existence of activities and reduction of displacement of existing activities also appears as a key objective of the draft Welsh National Marine Plan (Plan Objective 4) (Welsh Ministers, 2015). The Plan provides a concrete definition for co-location "*a subset of co-existence, where multiple developments, activities or uses co-exist in the same place by sharing the same footprint or area*". The Plan includes policy AQU-03 that clearly promotes co-location of aquaculture within offshore wind farms or within tidal lagoons.

6) MUs and land-based activities

The MU is connected to land-based activities as follows (now and in the near future):

- On-land infrastructure: electricity supply cables on land including landing site for their service and maintenance boats and staff; and storage space for supplies.
- Personnel: potential sharing during non-specialised tasks of constructions, operations and maintenance, of personnel who must commute from land to sea and vice versa.
- Waste material not allowed in the waters must be managed on land; carbon offsetting activities would be on land as well.

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7) Knowledge gaps for MUs

Wave technology has been proven but its commercial development at scale is still in early stages. Furthermore, uncertainty about environmental impacts from the MU continues to be a challenge for industry regulators and advisors (TCE, 2015). Wave technology limitations include going into rougher deeper waters; and fully understanding how biofouling would affect the wave technology especially at large scales. A key research challenge is R&D that results in reducing unit costs of electricity to competitive levelised costs – as this would be the clincher in whether it is a viable source of energy or not. Furthermore, research into optimal combinations of electricity conversion, storage and efficient connection into the grid, is required.

8) Actions to develop / widen / strengthen MU in the case study area

At an EU and national level there is need for the MU policy to be explicitly linked to action-forcing conventions for reducing greenhouse gases (GHG) emissions e.g. Paris convention. More locally, policy-makers and regulators should clearly define and put requirements for the MU; including the definition of co-location to cover 'non-anthropogenic uses', such as marine mammals and environmental conservation.

Policy makers and regulators need to produce formal guidance documents to facilitate and streamline the MU licensing and leasing process (e.g. seabed leasing for an MU development). This may save time which is critical for business ventures.

Regulation- and policy-makers at an EU, national and local level could also consider:

1. Create long-term explicit requirements and enabling conditions (e.g. subsidies), with flexible time-related targets for stated MU. This could integrate both concept and performance parameters e.g. 'GHGs reduced' as an MU, to make it attractive, even for a ring-fenced period e.g. 10-20 years.
2. Offer tangible financial incentives for "added values" from MU to local society e.g. mid- to long-term jobs created; or within broader "Good Environmental Status" or "ecosystem services" approach provided in EU and local marine environmental protection policy.
3. Funding authorities avail ring-fenced funds for MU for both "exploratory", "piloting" research and "large scale deployment".

6.1.2 Focus Area 2: Boosting Blue Economy

1) Societal added values from MU

Main benefits from the expansion for the MU, real and anticipated to accrue, are as follows:

- Integration of small-scale developers (e.g. shellfish farmers) and boosting the local economy
- Local communities could benefit from the MU by provision of energy, especially for off-grid locations, further reducing fuel poverty.

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- Job creation, locally, to support both sectors; and nationally as maintenance / repairs and auxiliary manufacture occurs.
- Savings from avoided costs for GHG reductions by country as a whole.
- Prestige of country being a leader in MU innovation, translating into income associated with "branding", "patents" and further R&D funds.

2) Attracting investors

Once the MU is proven at scale and takes off, then leadership and benefits from being a "first adopter" will attract investors to Scotland, from local and global sources.

The green credentials associated with the MU and the premium product generated would further attract developers in the region. Local communities could also invest in MUs, for instance though buying of shares.

3) Interest of potential investors in MU

Currently, the main interested investors in the MU are the 2 operators identified in this study, including EU's funding agencies. However, private wave energy developers exist in the vicinity, with national and global interests, and are likely keeping a keen eye to see proof of scalable concept for them to invest in the MU.

4) Communication and proximity between categories candidates

It is difficult to observe actual communication between potential MU investors, but it is assumed that as soon as proof of profitable and scalable MU is ascertained, relevant partnerships will emerge, perhaps facilitated by sectoral institutions. Key institutions most likely engaged in the MU discussions may include: commercial businesses, regulators and policy makers, business support (e.g. the Scottish Aquaculture Innovation Centre) and intermediaries (the Scottish Salmon Producers Organisation, Scotland Food and Drink, Association of Scottish Shellfish Growers and other businesses in the sector); the National Grid UK, etc.

5) Opportunities for training and job creation in your area?

The wave technology company did not divulge exact details, but are training in-house for data collection and operating the technology on site. There was scope for hiring specialised and skilled staff but no numbers were given. Training of employees in the MU could also be provided through courses such as the 'Maritime skills certificate' of the University of the Highlands, West Highland College[6].

6) Socio-economic added values for the local community

6 Available at: https://www.whc.uhi.ac.uk/courses/certificate-maritime-skills [Accessed: 27/11/2017]

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See above, answer to Question 1: Societal added values from MU.

6.1.3 Focus Area 3: Improving environmental compatibility

1) Environmental added values of Mus

The MU could partly enable mitigation of adverse environmental impacts from both developers, including the reduction of GHG emissions. Investing in sustainable aquaculture practices would also contribute to wild salmon stock recovery and mitigate the bycatch issues associated with the commercial salmon fishery.

2) Nature conservation and MUs

There is no evidence that freeing sea space for nature conservation is a current driver for the MU. To link MU development / widening / strengthening to improved environmental compatibility with maritime activities, policy-makers need to define co-location to cover 'non-anthropogenic users', such as marine mammals and environmental conservation. Such is for instance the case of tidal energy development in line with marine mammals (seals) and wild salmon conservation objectives.

Also, planning guidance and regulatory supplementary guidance need to explicitly integrate MU concept with GES indicators, as a mechanism for linking MU and nature conservation.

3) Examples of win-win solutions triggering both socio-economic development and environmental protection

Already, wave technology is providing green electricity and displacing GHGs that would have arisen from diesel generators, but the scale is still low as it meets only about 15% of electrical demand from the Aquaculture site.

4) Promoting MU development / strengthening according to environmental sustainability principles

Would the availability of a vision/strategy (e.g. at national or sub-regional level) be helpful? Yes, but only if it comes along with financial incentives or measures that lower investment risks. Clear targets from such an MU are also needed in order to assure investors that there energy is needed.

Would a feasibility study including evaluation of alternative scenarios be helpful? Partly - detailed simulations are helpful – but a scalable demonstration showcasing viability is what would be most useful.

5) Blue/green knowledge / technology for MU development / strengthening

The main research need remains scalability and deployment in deeper and more exposed locations, to allow for exploitation of the abundant wave energy out there. Progress exists in sea lice disease treatment through routes other than chemical treatment, in particular the use of 'cleaner fish' (wrasse, lumpsuckers) to prevent sea lice (e.g. Scottish Aquaculture Innovation Centre). This would

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strengthen the aquaculture component of the MU. The Integrated Multi-trophic aquaculture (IMTA) approach also offers environmental benefits worth pursuing at large scale.

6) Promoting MUs through SEA/EIA procedures

Licensing and regulating authorities need to streamline the Environmental Impact Assessment (EIA) process within an MU approach; to deepen "deploy and monitor" as opposed to the more rigid and stricter "precautionary principle"; and provide formal guidance that allows EIA for an existing use to facilitate licensing process within an MU activity that is staggered. This prevents the EIA being treated as new and in disregard to the material fact of an already existing use within the same space. This may save time which is critical for business ventures.

A circular planning approach, such as the one followed by the Scottish Offshore Renewables Research Framework (SpORRAn) (MS, 2017), throughout the project development, from planning to consenting could aid planning initiatives. Such an approach would enable integrating new knowledge as this becomes progressively available, such as new insights on resource availability and site suitability, as well as the scoping opinion of developers. Such a planning process could guide consultation analysis, for instance by the adoption of a 'least contentious' decision, in each case enable decision-makers in making a fully informed decision.

Maintaining a dedicated on-line portal for MU EIAS wold help accumulate knowledge and "good practice" in such a complex and challenging EIA field where use(r)s are joined as opposed to traditional EIAs for single use projects.

6.2 MU Combination: Shipping Terminal and Marine Renewable Energy

Potential alternative green energy generation solutions to replace diesel fed auxiliary generators used by ships berthed in port.

6.2.1 Focus Area 1: Addressing MUs

1) Establishing, widening and strengthening MUs in the case-study area

The general framework of co-existence of ports with green energy either involves OW energy brought onshore, supplied to an electricity substation at a port and transmitted via the station to the national electrical grid and/or or ports serving as the operation and maintenance base of the OWF (e.g. Port of Blyth[7]; Port of Newhaven[8]). Co-location could be widened to include the supply of green energy generation solutions to cover part of the energy requirements of a port.

From the perspective of energy developers the main motive for the MU is the ability of transmitting and selling produced energy. Ports are generally strategically located and have a sound connection to the electrical grid. Port authorities/developers could benefit from the provision of energy and

7 http://portofblyth.co.uk/offshore-energy-support-base/

8 E.ON Energy (2017) Source: https://www.eonenergy.com/about-eon/our-company/generation/planning-for-the-future/wind/offshore/rampion-offshore-wind-farm/building-rampion-onshore/operations-and-maintenance-base [Accessed: 18/11/2017].

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cover part of their energy demands, especially ports located in rural areas away from major hubs (e.g. Wales, western coast of Scotland). If such energy is from a renewable source, then the potential for reduced carbon emissions and also reduced carbon footprint of freighted goods will be significant, contributing to the overall fight against climate change agenda.

As regards the investment on offshore energy (wind, wave) from the side of the port, this would require granting a lease for the offshore site/sea-bed from the competent authority, the Crown Estate or Crown Estate Scotland in the case of the UK. Port developers find this prospect unnecessarily complicated and costly, especially when considering that they could invest in onshore renewables in the port, for which they have ownership, jurisdiction and are the statutory authority.

Onshore renewable sources (e.g. solar, onshore wind) constitute viable options and are described as beneficial through development of valuable (energy) infrastructure in port areas of secondary value (what was termed by interviewees as '*dead*' areas). Ports that invested in onshore wind energy report cost savings on electricity usage, with examples of electricity generated used to power pump stations for the operation of lock gates. Public/trust ports also mention that a main objective of investing to renewable energy was to reduce CO2 emissions and overall carbon footprint. They stress that this objective was not a legal requirement but that environmental considerations are key for their functioning as public/trust ports.

With reference to the potential of electric energy produced from renewables used for the powering of auxiliary engines of vessels while berthed ['shore-side electricity', offshore power supply (OPS), or 'cold-ironing'], this prospect depends on a variety of different factors. First, the type, size and class of vessels accommodated at a particular port. Certain vessels (tankers that are fuelled by part of the oil they transport; cargo vessels that travel large distances and between different destinations) would not shift engines to electric. For these types of vessels other Alternative Maritime Power (AMP) sources (e.g. Liquefied Natural Gas, LNG fuel; biofuels) could constitute more viable/cost-effective options. Private ports primarily accommodating such vessels would not see the added benefit of investing considerable funds to shore-side electricity infrastructure. Such ports would include base ports for the O&G sector (e.g. Sullom Voe). Vessels that could convert to compatible engines would include smaller size vessels, traveling between set destinations and short distances, or having a fixed home port, such as pilot boats, small ferries, and fishing vessels. Consequently ports that accommodate these types of vessels would benefit from shore-side electricity infrastructure development. Second, the location of berthed vessel relative to port. It may be difficult to transport electricity to vessels not berthed on shore-side, anchored within port but away from shore (e.g. port of Leith, Scotland approx. 30% of berthed vessels anchored 1 mile from shore).

SSE generated by Alternative Maritime Powers (AMP) could take place in small docks and ports in the western coast of the UK. SSE could have potential in small coastal communities in the west and island communities in the Inner and Outer Hebrides, to accommodate lifeline ferry routes. Specific locations would include the sites and ports identified in the National Renewables Infrastructure Plan (N-PIR) (Map 10, Scottish National Marine Plan, MS 2015a). Relevant developments could follow the example of the island of Eigg that produces 100% of its electricity from renewable sources[9] and is considered among the most eco-friendly islands[10]. However, investment in SSE infrastructure would

9 https://www.theguardian.com/travel/2017/may/29/eigg-island-scotland-cycling-walking-kayaking

10 https://www.theguardian.com/environment/2010/jul/01/eigg-island-renewable-energy

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require co-ordination with local communities, ferry operators and other concerned publics, for preventing displacement of shipping and adverse socio-economic impacts. “Any marine and port development should not interfere with ferry services and essential connections should be safeguarded” (Policy Transport 3, Scottish NMP; MS, 2015a).

Key targets relevant with the implementation of the MU involve MARPOL Annex VI and industry goal (Global Shipping Industry) of reducing CO_2 emissions (per tonne/km) from shipping by 20% by 2020 and 50% by 2050 (International Chamber of Shipping, 2015); MARPOL (1997) reduction of air pollution generated from heavy duty marine diesel engines. Also, at an EU level, directive 2012/33/EU as regards the sulphur content of marine fuels; Directive 2014/94/EU makes reference to ‘shore-side electricity facilities as clean power supply’ (Articles 34; 35); Regulation 2015/757 on the monitoring, reporting and verification of CO2 emissions from maritime transport

2) Space availability for MU development

Space for further development in a port is limited, especially if the port is within the urban network. OWF operation and maintenance ports need to be in proximity to the OWF and have sufficient space for relevant quayside infrastructure and activities. Port needs to possess many requirements (depth of accommodating vessels; space for manoeuvring, distance to cranes/ infrastructure to fit and build turbine, etc.[11]). For using a port as their operation and maintenance base, OWF developers have requested in the past an area of at least 2 ha from potential candidates. Certain ports may not have adequate area to provide to potential investors. Non-base ports in OWF proximity that would still like to be engaged in the process could see benefits from accommodating survey vessels, construction vessels during OWF construction, but traffic would decline once OWF becomes operational. Redevelopment and real estate pressures frequently exist in ports and this further shapes the potential of establishing and or widening the MU.

The development of OW turbines within the marine area of the port would also have implications for space availability, relating primarily with constraints of shipping lanes and the impact for the port traffic. Moreover, the frequent dredging of shipping channels may interfere with underwater cables. Space availability and the layout of the port are defining factors for onshore development of green energy, and a port may have confined space for installing onshore wind turbines. A connection between berthed vessels and energy substation would be required. The power cable would connect to the meter house, MPAN[12], and channel through to connect to berthed vessels.

In terms of offshore developments, space should be carefully negotiated based on size and arrangement of installations, for instance spacing and layout of offshore wind turbines, as shipping lanes and other users must also be considered.

11 GL GH 2014. Assessment of Ports for Offshore Wind Development in the United States. Available at: https://energy.gov/sites/prod/files/2014/03/f14/Assessment%20of%20Ports%20for%20Offshore%20Wind%20Development%20in%20the%20United%20States_1.pdf [Accessed: 20/11/2017)

12 A Meter Point Administration Number, also known as MPAN, Supply Number or S-Number, is a 21-digit reference used in Great Britain to uniquely identify electricity supply points such as individual domestic residences.

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3) MU combinations and potentials

Due to space requirements and restrictions, the MU would be promising for ports with disused facility areas. Disused port facilities in Swansea Bay, Wales (e.g. Milford Haven) for instance would benefit as 'demo centres' for testing the MU. Energy could come from planned and under development marine renewable projects in the area (wave, tide). Again, issues of local residents and communities objecting relevant development and visual impacts may be points of contention.

4) Resources to be shared between users

The most important resources to be shared between the users involve the actual port space and grid connection infrastructure. Staff could also be shared.

5) MU within policy

Certain policies of the Scottish NMP relate directly with the MU, especially policies for the shipping, ports, harbours and ferries sector (chapter 13 of the Scottish National Marine Plan, MS 2015a). The Plan describes in detail the significant role of ports in supporting the renewable industry (13.4) and how this could be achieved (13.15 - 18). The National Renewables Infrastructure Plan identifies port and harbours sites for the support of offshore renewable energy needs based on several best fit location criteria (SNMP, 13.15). Transport Policy 5 makes explicit reference to 'shore-side power': "P*ort and harbour operators should take into account future climate change and extreme water level projections, and where appropriate take the necessary steps to ensure their ports and harbours remain viable and resilient to a changing climate. Climate and sea level projections should also be taken into account in the design of any new ports and harbours, or of improvements to existing facilities*" (pg. 99, Scottish NMP, MS, 2015).

6) MUs and land-based activities

Harbour authorities, port owners and developers must account for the energy needs and obligations towards other users of the port that may include (i) Aggregates (e.g. tarmac), (ii) shipping, freight and trade (iii) Oil terminals, petrol, diesel (iv) tourism and recreation (e.g. leisure marinas) (vi) fisheries and aquaculture. Certain ports in the vicinity of an OWF may be more competitive to serve as base ports than others (more quayside space, cheaper rent).

7) Knowledge gaps for MUS

Significant capital expenditure is required for the implementation of SSE, shipside as well as on shore, and the actual cost effectiveness of any such system requires an in-depth operational study considering the size, frequency and duration of ships visiting a particular port (Sciberras et al, 2015). Key knowledge gaps in ports investing to green energy in the past included the fluctuation in feed-in tariffs. Also, issues related with onshore and offshore energy technology (inverted cabinets, salt area, corroding, seagulls dropping shells on solar panels, cracking), will require further research.

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An impact scenario analysis will also be required to ex ante understand where vessels will go if they decide to avoid ports where MU requirements have been imposed, although 'displacement of shipping should be avoided where possible' (Scottish NMP, MS, 2015a).

8) Actions to develop / widen / strengthen MU in the case study area

The majority of ports in Europe, including major ports (Rotterdam, Antwerp, Hamburg) are publicly owned, thus government policies and plans are usually in line with port development and operations. Sectoral initiatives also exist to reduce port-related emissions both at an international and regional level e.g. World Port Climate Initiative, WPCI). The European Sea Port Organisation (EPSO), offered a port sector-specific environmental management standard, and in 2013 11 UK ports have been accredited as 'eco-ports'. The Scottish Energy Ports programme is set to improve the use of ports across the Scottish coastline for the infrastructure of the energy sector[13]. Individual ports also include in their strategic vision the support for the offshore energy sector. Relevant programmes could integrate considerations for further development of green energy used for SSE and the sector will have a key role to play in suggesting where and how to implement relevant initiatives at a larger scale of development (see answer to Focus Area 2 Question 4: Communication and proximity between categories candidates).

Public/trust ports that have invested in the past in green energy generation argue that investments required a huge amount of knowledge and background research. Overall, investments had to happen from scratch "making documents up from scratch, templates, advice" (interviewee: port developer no. 2). They state that the development of guidelines at an EU and national level on how to engage in such projects would be very helpful.

Ferry routes are subsidised by the Scottish government and possible development of the MU would require further subsidies provided to that end. As discussed, there could be potential for disused port facilities for the pilot testing of SSE from AMP, including offshore marine renewables ('demo zones') (research and technology actors).

The potential benefits and likely scenario for local communities to gainfully invest in such an MU, also needs research.

A major consideration should be ensuring vessel displacement does not occur as a result of implementing the MU in a particular port. If the MU is imposed without taking into account this factor, vessels that cannot readily shift to SSE, such as tankers etc., will shift activity to other ports and travel further to find suitable energy sources. To prevent such a condition, MU facilitation and policy development is necessary and needs to derive from an EU level, because otherwise certain ports and developers will become uncompetitive.

6.2.2 Focus Area 2: Boosting Blue Economy

1) Societal added values from MU

13 Available at: https://www.sdi.co.uk/knowledge-hub/articles/insight/scottish-energy-ports [Accessed: 21/11/2017].

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Local community will likely benefit from the grid connection, energy generation from renewable sources, Jobs creation, and if joint owners of MU, from income associated with tradable “carbon credits”. Fuel poverty may also be reduced.

2) Attracting investors

(See answer to Focus Area 1 Question 1: Establishing, widening strengthening MUs).

3) Interest of potential investors in MU

(See answer to Focus Area 1 Question 1: Establishing, widening strengthening MUs).

4) Communication and proximity between categories candidates

For promoting OWF and ports co-location the collaboration between harbour authorities/port developers (esp. private) and seabed licensors (TCE, TCES) is crucial. Both stakeholders would be willing to engage in further discussions, as stated during the stakeholder engagement. Marine Scotland could be the facilitator. An interesting idea that was set forward by the interviewees was development of interactive online tools (‘internet dating app’) where potential investors could express their interest in developing OWF, connecting with ports etc.

5) Opportunities for training and job creation

A requirement for the implementation of the MU is also the presence of skilled workforce in the vicinity of the port. It is true that the both aspects of the Mu would generate jobs, and encourage skills acquisition as well. For example 40 people were directly hired in the RAMPION OWF for the Newport port. Training of employees in the MU could also be provided through courses such as the ‘Maritime skills certificate’ of the University of the Highlands, West Highland College[14].

6) Socio-economic added values for the local community

Other than job creation, training and skills development, local communities could benefit from the MU by provision of energy, especially for off-grid locations, further reducing fuel poverty. Communities would also benefit from the reduction in GHG emissions.

Another advantage is the regeneration of disused port areas: disused facilities in certain ports (e.g. Milford Haven) could be used as test demo centres that would progressively enable the building up of expertise and potentially the commercial application of the MU.

14 Available at: https://www.whc.uhi.ac.uk/courses/certificate-maritime-skills [Accessed: 27/11/2017]

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6.2.3 Focus Area 3: Improving environmental compatibility

1) Environmental added values of Mus

A major environmental added value from the development of the MU is reducing GHG emissions, in line with key policy objectives “Prevention of pollution by international shipping represents a significant element of the work of the IMO where substantial actions have been made to alleviate shipping emissions” (MS, 2015a, 13.29). “Climate change mitigation, domestically, involving investment in technological changes in ferries to decrease CO_2 emissions” (MS, 2015a, 13.32). As such, a key policy direction could be to concentrate such MUs in emission hotspots, with reduction of GHG emissions being a key objective, at optimal cost-effectiveness.

Measures to support shipping emissions reduction targets will be necessary. This may include considering increasing availability of shore based electricity in ports for smaller or recreational vessels, seeking to ensure that ferries and other ships are not forced to take longer routes, and encouraging efficiencies in fleet management and technology advances. Modal shift is currently being supported through Scottish Government Grants150. On a large scale it may require associated port and harbour development.

For certain ports (esp. shallow) nearshore location of MU might have significant impacts on navigation, shipping lanes. As such anchored vessels may not be accommodated. Nearshore location of MU might have visual impacts (OW turbines) and local communities might oppose MU. Impacts upon recreation (sailing) and local non-statutory stakeholders (e.g. local sailing clubs) might oppose MU. Stakeholder consultation necessary

2) Promoting MUs through SEA/EIA procedures

Maintaining a dedicated on-line portal for MU EIAS wold help accumulate knowledge and “good practice” in such a complex and challenging EIA field where use(r)s are joined as opposed to traditionally applying singly cations for license.

Moreover, specific training needs should be identified for EIA/SEA professionals, to anticipate the market for MUs, which will be particularly challenging in its cumulative impacts assessment aspect, in a way that is unlike traditional single use EIAs/SEAs.

The EIAs/SEAs will have to find a way to be proportionate, recognise knowledge from earlier single use EIA in the area, and be quick enough without compromising environmental protection. The staggered nature of the MU should count as an advantage in the EA processes.

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7 STAKEHOLDER ENGAGEMENT AND LOCAL STAKEHOLDER PROFILES

7.1 Activities to engage stakeholders

The main stakeholder engagement method was semi-structured interviews with key respondents. Interviewees were selected to include main statutory and non-statutory institutions relevant for the selected MUs in the case study area. Interviewees were also selected to correspond to the categories of stakeholders suggested by the WP3 methodology outline for the relevant focus areas of each of the selected MUs. Analysis of MUs pertaining to marine renewables and aquaculture was performed according to the guidelines for focal areas 1: "Addressing MUs" (existing case of MU) and 2 "Boosting blue growth" (future offshore aquaculture development). For MU shipping terminal and green energy generation, analysis was performed according to focus areas 1 and 2. However, effort was made to address all KEQs for all respective MUs to acquire a sound overview of all aspects that relate to them.

Invitations were sent to potential interviewees via email and follow-up interviews were arranged. Interviewees would also refer other potential candidates for further interviews (snowball sampling). Interviews generally lasted between 1 -2 hr and were structured along the framework of WP3 methodology to address the key Evaluation Questions, especially for the relevant focus areas. Interviewees for MU 'Aquaculture and wave' and MU 'OWF, wave and 'offshore' aquaculture' were the same.

A total of n=14 interviews were conducted with key stakeholders (Appendix 3). For MU combinations of marine renewables and aquaculture, interviewees primarily had a commercial business, policy maker or regulator background. A total of seven interviews were performed for the MU, of which: three commercial developers (1: aquaculture, 2: energy sector), three regulators (1: aquaculture, 2: cross-sector licensors); one policy maker (cross-sector).

For the shipping terminal and green energy generation MU, a total of seven interviews were performed of which: two with port developers/harbour authorities (i.e. commercial businesses) (1: trust, 1: private), one with society representative (city council), two with policy makers and two with regulators (licensors). As no existing cases of MU implementation exists in the cases study area's vicinity, commercial developers included port developers/harbour authorities in the broader North Sea/North Atlantic region.

Information acquired during the interview was put into a DABI format and sent to the interviewees for scoring, along with clear directions on the scoring framework. The DABI evaluation and scoring framework was also discussed during the interview. Two of the interviewees followed up and provided scores for the DABI. Six of the interviewees did not follow up and scores were allocated by the research team based on their expert knowledge and assessment of responses from the interviewees. To the rest of the interviewees (six) the DABI has not yet been sent and scoring has been performed by the research team based on expert knowledge and assessment of responses from the interviewees.

The vast majority of interviewees (MU wave & aquaculture: 6/7, MU shipping terminal & green energy: 6/7) indicated in the confidentiality form that they do not want their information shared or words attributed to them, thus personal information in the Appendix is withheld. They all indicated that they would like to receive information on the MUSES and would like to be invited and potentially participate in future stakeholder events.

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Workshop and conference attendance also provided important insight on how key stakeholders not included in the pool of interviewees view and relate to the case studies MUs. These included among other the Atlantic Action Plan 2017 meeting in Glasgow, for participants relating to the sectors or the case study area.

7.2 Local stakeholder profiles

7.2.1 MU combination aquaculture and renewable energy

Aquaculture

Aquaculture commercial businesses have a strong overall interest towards the MU, as signified by relevant pilot and commercial developments of the MU in the study area. Salmon farms typically use diesel generators which are off-grid, vulnerable to high costs and can be potentially replaced by wave energy sources. It is also envisaged that future larger scale developments will reduce the costs and expenses and result in wave energy sources achieving cost parity with diesel.

Aquaculture regulators and policy makers highlight as key drivers for potential MU the future need for space for aquaculture and the need for the sector to reduce its carbon footprint. They suggest that co-location could be particularly promising for small-scale aquaculture developers especially shellfish farmers, with mussel long-lines acting as natural barriers in high energy sites, offering shelter to offshore energy developers.

Business support includes the Scottish Aquaculture Innovation Centre and intermediaries include the Scottish Salmon Producers Organisation, Scotland Food and Drink, Association of Scottish Shellfish Growers and other businesses in the sector. The need for space for the future expansion of the sector and the industry's sustainable development are also major concerns of theirs, as reflected in the 'Scottish aquaculture: a view towards 2030' roadmap[15].

The geographical scale of aquaculture (salmon) developers is national, while strong global market ties exist, with Scottish salmon comprising a premium commodity. Shellfish aquaculture has a more domestic scale. Shellfish and seaweed cultivation also includes small and medium size enterprises. Aquaculture commercial businesses, intermediaries, business support, policy makers and regulators have a strong power to influence directly the further expansion of the MU, also through research and investment in offshore aquaculture development.

Renewable energy developers

Energy developers have a strong overall interest towards the MU, as signified by relevant pilot and commercial developments of the MU in the study area, by the private sector company of international operations. It is also envisaged that the numerous renewable technology and energy companies are live to the profit motivation and will come on board when conditions are right.

The national government and electrical energy companies and regulators and policy makers are committed to the future and targets for the sector to reduce its carbon emissions and produce and consume renewable electricity.

Cross-sector

15 http://scottishaquaculture.com/wp-content/uploads/2017/02/Scottish-aquaculture-—-a-view-towards-2030.pdf

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Among the key cross-sector regulators are the statutory consultees who are key in EIA process; and their attitude towards the MU is generally positive. It is suggested that they could be more proactive in promoting an environment for such MUs.

7.2.2 MU combination shipping terminal and green energy generation

Port developers

The attitude of port developers towards the MU seems to be 'negative but can positively influence barriers'. Developers do not seem to find the particular MU viable for implementation in the immediate future. However, they anticipate that relevant regulations may become more stringent in the future, in which case they would have to give the option closer consideration.

Regulators and policy makers stress the need for careful planning of the MU to prevent displacement of vessels in other ports. To that end, they mention that planning and implementation of the MU should be EU wide, and could be facilitated by the EU. They also mention the need for the careful planning of connection of the OWF to the port and clear communication among the developers prior to the implementation of such a connection.

Renewable energy

Renewable energy developers have a strong overall interest in the MU, as this is an opportunity for them to connect to the grid, and directly distribute part of the produced energy. As ports are strategically located and connected to the electrical grid, this seems particularly advantageous to them.

Cross-sector

Certain cross-sector stakeholders (sea-bed licensors) mention that the MU could provide the potential for a closer collaboration among them and port developers.

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8 CONCLUSIONS AND RECOMMENDATION FROM THE CASE STUDY TO THE ACTION PLAN

8.1 Current stage of MU development

Different stages of MU development exist in the study area. MU aquaculture (finfish) and wave energy has already been implemented at a commercial level. However, it only meets about 10% of the potential demand for the aquaculture operator at the site, with a need to explore how to scale up wave energy operations to a level that can reliably supply the electricity demand now and in the future. This is the biggest challenge for the MU: scaling up to a level where the aquaculture partner is mutually reliant on the wave technology and the wave energy developer is profitably operating at a level that can compete with alternative energy sources. The scope for scaled up application on site is significant as the aquaculture operator is still expanding and is building six new farms in the vicinity. Expansion of the MU could also take place in appropriate locations further offshore, provided constraints relating primarily to technology for 'offshore' aquaculture and wave energy are lifted.

MU shipping terminal and green energy generation is promising as a concept and is yet to be trialled and implemented. Key issues that determine to a large degree ports' business models and the potential for MU development relate with port ownership status (private or public/trust) and the type, size and route of accommodated vessels (e.g. cargo, tankers etc.). Other issues involve technological and operational constraints in linking offshore energy to the port and subsequently using energy for shore-side electricity. Once such hurdles are overcome the net benefits in terms of contribution to climate change mitigation will be significant and worthwhile for the society. The MU would further contribute to energy provision for rural communities with little connection to the grid.

8.2 Best potential MU combination(s) for the future in the area

The MU aquaculture and wave energy could be further expanded to include:

- Wave and shellfish: near shore, within appropriate locations (Scottish National Marine Plan, MS, 2015a)
- Wave and shellfish: near shore, at more exposed sites. Specifically, mussels' long-lines could act as natural barriers to very dynamic wave and tidal conditions in certain sites and be a driver for wave developers to co-locate.
- Aquaculture, wave and offshore wind (OW): near shore, at more exposed sites, within future sites of OW, wave planned developments (Scottish National Marine Plan, MS, 2015a). Locating in deeper offshore waters may occur mid- to long term, as technology readiness and viability of scalable MU are yet to be demonstrated.

As regards the MU shipping terminal and green energy generation, the following MU combinations would be suitable in the case study area:

- Shipping terminal and offshore wind: after consultation with local communities, connecting areas within shipping terminals for the berthing of appropriate vessels (ferries, pilot boats, fishing vessels) to future sites of OW developments (Scottish National Marine Plan, MS, 2015a).

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- Shipping terminal and wave and/or tidal energy: initially 'demo zones', connecting disused port facilities with wave and/or tide energy; once know-how established, the commercial application of MU would be feasible.

8.3 Key solutions and actors that can contribute to enhance MU in the area.

Policy makers and regulators at EU, national and local levels, need to define MU adequately and comprehensively, and provide explicit requirements and formal guidance for MUs, so that relevant developments are treated as such within the leasing/licensing process. At a local/national level, this would involve the main competent authorities, namely the Marine Management Organisation (MMO) and Marine Scotland (MS), but also the Crown Estate, Crown State Scotland, SNH, SEPA etc. that may require a more thorough definition of MUs. Such an MU definition should also address and integrate non-anthropogenic uses (conservation, protected species, etc.). Regulators and policy makers create a long-term and predictable environment to address demand and supply sides of MUs. The demand side can include targets for production, consumption and zoning for MUs; the supply side can include financial incentives for MU-generated added benefits e.g. green energy and achievement of pre-set GES parameters or Ecosystem services.

MUs should be linked to the objectives of GHG emissions reductions, in particular the Paris agreement. Planning of MUs at an EU level is advisable for certain MUs such as shipping terminal and green energy generation, to enable locations and businesses that do implement MUs to remain competitive and prevent a shift to other locations with fewer requirements.

Significant capital expenditure might be required for the implementation of MUs. MU development needs to be aligned with insurance markets realities: the scope of an MU will differ from the scope of individual developers, especially relating to issues of health and safety and liability. Power imbalances that may exist among developers need to be resolved for further MU development. To that end, MS, The Crown Estate, Crown Estate Scotland could be key facilitators.

For implementing MU shipping terminal and green energy generation, the closer co-operation among port developers/harbour authorities and the competent authorities for the seabed for the offshore renewable component (The Crown Estate and Crown Estate Scotland) is crucial. Moreover, guidelines need to be provided to port authorities for implementation of relevant MUs, to speed up the process of investing in MUs and attracting potential investors.

Integration of local communities in MUs, or the realisation of the added values MU developments can have for communities, could resolve issues of local residents and communities objecting relevant developments. Such examples include the actual energy provision from offshore renewables to communities; actual shares of communities in the MU; or infrastructure development, for instance shore-side electricity in ferry terminals.

Research funding authorities to avail adequate money for scaled-up development and deployment – to showcase commercial viability and also bring down levelised unit costs to competitive levels. For MU shipping terminal and green energy generation, progress is required on the connection of offshore energy to ports and the likelihood of shore-side electricity generated from offshore renewables. To that end, important information might come from ongoing developments (e.g. Port of Blyth) and potential 'demo zones' for the MU.

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An EU, national and local level "leader" to champion MU concept and deployment is needed, focusing on creating awareness that will underpin a "niche" market for MU branded products as well as deliver standardised shipping terminal provisions for MU energy.

A regulating and policy-making body such as Marine Scotland should consider maintaining a dedicated on-line portal for MUs and EIAs in MUs. This would not only help accumulate knowledge and "good practice" but provide a significant mechanism for lessons learning and information exchange, which could underpin future MU uptake and deployment and reduce perceptions of risk. Similar interactive tools could also be developed to enable links between interested developers in MUs via e.g. the TCE website.

Finally, at a least a single scale-up showcase of success is needed in each MU, to give confidence in the investment sector. This requires a coordinated cross-sector group of actors, perhaps led by a key policy maker or EU/ nationally based Innovation and Development institution.

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APPENDIX 1 – SCORED DABI TABLES

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	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7		
Combination: wave energy and aquaculture	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
DRIVERS									
Category D.1 - Policy drivers / Institutional									
Factor D.1.1 - Promotion of co-location (incl. wave and aquac.) in Marine Plans, esp. for rural areas (incl. Outer Hebrides, Wales) (MS, 2015; NPF3, Welsh Government)						3	3	3,0	3,0
Factor D.1.2 - Promotion of marine renewable energy National, sub-national policy (MS NMP, 2015; NPF3, Welsh Government)	3							3,0	3,0
Factor D.1.3 - Sectoral plans on marine renewable development (ORJIPs, OREDPs , Ocean Energy strategic roadmap)	2							2,0	2,0
Factor D.1.4 Policy directives for the doubling of aquaculture production				3				3,0	3,0
Factor D.1.5 Joint ministerial statement aquaculture development (Scottish Gov., 2017) and 'multi-annual plan' promoting co-existence				3				3,0	3,0
Factor D.1.6 Strategic plan vision for aquaculture (jobs and benefits)				2				2,0	2,0
Factor D.1.7 Licensors/leasing authorities now strongly considering the case for co-location							2	2,0	2,0
Factor D.1.8 Social license from being "Green"		1	1					1,0	1,0
Factor D.1.9 Binding Govt. targets on RE and carbon emissions			3					3,0	3,0
Average	**2,5**	**1,0**	**2,0**	**2,7**		**3,0**	**2,5**	2,3	2,3
Category D.2 - Interactions with other uses (already present in the area)									
Factor D.2.1 From Marine renewable sector viewpoint, co-location could contribute to reducing project costs (pre-development)	3							3,0	3,0
Factor D.2.2 Activities taking place in same seabed area, i.e. requiring less space/seabed, esp. as space becomes progressively limitec						2	3	2,5	2,5
Factor D.2.3 Already existing aquaculture infrastructure (eg transport boats) facilitated WE			1					1,0	1,0
Average	**3,0**		**1,0**			**2,0**	**3,0**	2,3	2,3
Category D.3 - Economic drivers									
Factor D.3.1 Funding schemes to promote marine renewables esp. rural areas (EU ESF, RDF; Innovate UK etc.)	3		1					2,0	2,0
Factor D.3.2 Co-location reduces operational, investment and maintenance costs (post-development)	2							2,0	2,0
Factor D.3.3 Opportunity to supply numerous island populations still off-grid; Remote areas with limited power/energy sources could comprise new sites for aquac. (shellfish) and be a driver for MU; Likewise, marine renewables could benefit off-grid communities				3	3		2	2,7	2,7
Factor D.3.4 Savings on energy costs for Aquaculture		1	1		3		2	1,8	1,8
Factor D.3.5 Showcasing successful MU - developers working together		1	1				2	1,3	1,3
Factor D.3.6 Potential profits in international and local RE markets			3					3,0	
Factor D.3.7 Availability of seed capital			2					2,0	
Factor D.3.8 Falling unit costs of RE (more competitive with alternative energies)			3					3,0	3,0
Average	**2,5**	**1,0**	**1,8**	**3,0**	**3,0**		**2,0**	2,2	2,2
Category D.4 - Societal drivers									
Factor D.4.1 Co-location could be a way for 'little guy' (i.e. small-scale developers) to be engaged in higher numbers				2				2,0	
Factor D.4.2 Being seen as "Green" will enhance social acceptance		1	1					1,0	
Average		**1,0**	**1,0**	**2,0**				1,3	1,3
Category D.5 - Research drivers									
Factor D.5.1 Insight from past research projects (MARIBE)	2							2,0	
Factor D.5.2 Marine renewable developers progressively more engaged in research projects (MARIBE, Aquatera and Columbus project)	2							2,0	
Factor D.5.3 SAIC -Research in sea lice treatment and new farmed species (e.g. Scotish Aquac. Innovation centre)				2	2			2,0	
Factor D.5.4 Considerable research on site suitability for marine renewables					2			2,0	
Average	**2,0**			**2,0**	**2,0**			2,0	2,0
Category D.6 - Physical environment / resource availability drivers									
Factor D.6.1 Substantial availability of wave resources (esp. NW UK)	3		3					3,0	
Factor D.6.2 Space/location availability for aquaculture sector (further expansion)		3		3				3,0	
Factor D.6.3 Mussels long-lines could act as barrier to very dynamic wave/tidal environment (shelter effect)				2				2,0	
Factor D.6.4 MU was in proximity to land, facilitating maintenance and service				3				3,0	
factor D.6.5 Offgrid diesel generators replacable by RE			2					2,0	
Average	**3,0**	**3,0**	**2,5**	**2,7**	**2,0**			2,6	2,6
Category D.7. - Environmental drivers									
Factor D.7.1. Climate change effects (decrease in wild salmon stocks) leading to promotion of aquaculture; need to reduce effects of bycatch in wild fisheries				2				2,0	
Factor D.7.2 Sheltered sites for Wave technology			1					1,0	
Average			**1,0**	**2,0**				1,5	1,5

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7		
Combination: wave energy and aquaculture	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
BARRIERS									
Category B.1 - Legal barriers									
Factor B.1.1 Scottish NMP (MS, 2015) 'presumption against further finfish aquac. in N.E coast'				3	2			2,5	
Factor B.1.2 Not always possible to co-locate activities under current leasing scheme of the Crown Estate (unless 'demo zones'	3							3,0	
Factor B.1.3 Environmental, conservation regulations to be considered					2			2,0	
Factor B.1.4 Absence of clear marine planning requirements and supplementary guidance that integrate Mus							2	2,0	
Factor B.1.5 Brexit uncertainties over regulatory frameworks and targets			1,0					1,0	
Average	**3,0**		**1,0**	**3,0**	**2,0**		**2,0**	2,2	2,2
Category B.2 - Administrative barriers									
Factor B.2.1 Slow, complicated, demanding EIA & consenting regimes may hinder MU developers		2	2		3		3	2,5	
Factor B.2.2 Regulator's rigid interpretation of the law and MU could prevent co-location with non-anthropogenic uses					1			1,0	
Factor B.2.3 Licensors/leasing authorities haven't considered a lease for MU; Usually, single, sectoral activity either aquac. or energy; i.e. separate applications			1			2	2	1,7	
Factor B.2.4 If MU staggered, may require change in location, editing existing framework/plan (more complications							2	2,0	
Factor B.2.5 SEPA not supporting large scale operations, needed for profitability in a more globally competetive market		3	3					3,0	
Factor B2.6 Regulating authorities not knwoledgeable of the MU sector in great detail			2					2,0	
Average		**2,5**	**2,0**		**2,0**	**2,0**	**2,3**	2,2	2,2
Category B.3 - Barriers related with economic availability / risk									
Factor B.3.1 Developers (wave, aquac.) not currently integrated at a level that supports adequate / detailed co-operation for MU; more an issue of a 'gentleman's agreement' between developers	3					3	2	2,7	
Factor B.3.2 Lack of a defintive brand or market niche for sp. cultured within MU operations (perhaps recognisable quality mark				3				3,0	
Factor B.3.3 Close-containment aquaculture systems may provide competing alternatives to marine MU in the future				2				2,0	
Factor B.3.4 Access to finance by developers for the MU to be commercially profitable			2		3			2,5	
Factor B.3.5 Lower levelised costs for non renewable carbon-based energy sources					3			3,0	
Factor B.3.6 Unclear who funds the support / auxiliary infrastructure required for MU (e.g. cable connection)					2			2,0	
Factor B.3.7 Commercial viability of MU development, a key evaluation criteria from leasing / licensing / financing perspectives						3	3	3,0	
Factor B.3.8 From the perspective of energy developer there needs to exist adequate and reliable demand for produced energy							3	3,0	
Factor B.3.9 Inadequate integrative planning / coordination between MU sectors (long term business plans do not tie together of two distinct developers)			2					2,0	
Factor B.3.10 Lost profit (and fish) in case of technology failure		2						2,0	
Factor B.3.11 Disequality in financial size and interests - Power imbalances between the two developers (business as usual, we domn't need them)		1						1,0	
Factor B.3.12 Risks of MU viability unclear to the potential financers (when addressed by one of the MU developers)			2					2,0	
Average	**3,0**	**1,5**	**2,0**	**2,5**	**2,7**	**3,0**	**2,7**	2,5	2,5
Category B.4 - Barriers related with technical capacity									
Factor B.4.1 Wave energy requires specific wave and climate conditions that in the viewpoint of energy developer, may not be optimal for aquaculture	2							2,0	
Factor B.4.2 MU involves two very dissimilar activities to come together and apply as a single MU						3		3,0	
Factor B.4.3 Wave technology limitations, early stages of commercial development							2	2,0	
Factor B.4.4 Energy demands and supply of developers might not match		2	3					2,5	
Factor B.4.5 Challenges with storage, trasmission of produced enegy between the devleopers and access to main gric			2					2,0	
Factor B.4.6 Lack of demo, pilot tests etc. to demonstrate how it actually works and viability of MU			2					2,0	
Average	**2,0**	**2,0**	**2,3**			**3,0**	**2,0**	2,3	2,3
Category B.5 - Barriers related with social factors									
Factor B.5.1 Commercial fisheries and auxiliary businesses may contest planning sites due to potential impacts on wild salmons		2	2	2	2			2,0	
Factor B.5.2 Local communities, anglers may contest planning sites due to potential impacts on wild salmons		2	2					2,0	
Factor B.5.3 Other tenants may prevent the MU development						3		3,0	
Average		**2,0**	**2,0**	**2,0**	**2,0**	**3,0**		2,2	2,2
Category B.6 - Barriers related with environmental factors									
Factor B.6.1 MU requires specific conditions e.g. natural environment limits optimal aquaculture locations and type of species to be farmed				3		3		3,0	
Factor B.6.2 Sea lice impacts on aquaculture for aquaculture developer		1			3	3		2,3	
Factor B.6.3 Ground conditions / seabed may be challenging						1		1,0	
Average		**1,0**		**3,0**	**3,0**	**2,3**		2,3	2,3

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7		
Combination: wave energy and aquaculture	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
ADDED VALUES									
Category V.1 - Economic added values									
Factor V.1.1 Showcase and demonstratio for proof of MU concept and benefits		2	2					2,0	
Factor V.1.2 Conservation costs for sites can be shared		1	1					1,0	
Factor V.1.3 Green credentials leveraged for funding		1	2					1,5	
Factor V.1.4 Savings from labour crossover			1					1,0	
Factor V.1.5 Income from feed in tariffs			2					2,0	
Average		**1,3**	**1,6**	**2,0**				1,6	1,6
Category V.2 - Societal added values									
Factor V.2.1 Developer (aquc.) and aquac. clusters did considerable community engagement actions (Scottish Salmon Producer's organisation) ' Community charter'				2				2,0	
Factor V.2.2 MU would faciliate connectivity for isolated off-grid coastal communities via scaled down micro renewables					2			2,0	
Factor V.2.3 Community, education and employment opportunities					3	2	2	2,3	
Factor V.2.4 Local communities could also be 'developers' within the context of MAR. Partnership Authorities							2	2,0	
Factor V.2.5 Green credentials of MU enhance social acceptance; won EU Green award		2	2					2,0	
Factor V.2.6 Green energy supplied to local communities			1					1,0	
Average		**2,0**	**1,5**	**2,0**	**2,5**	**2,0**	**2,0**	2,0	2,0
Category V.3 - Environmental added values									
Factor V.3.1 MU could facilitate mitigation of adverse environmental impacts from both developers	2				3		2	2,3	
Factor V.3.2 Reduction of CO_2 emissions (overall reduced carbon footprint fro both developers)		1	3	2	3			2,3	
Factor V.3.3 Small sea surface area footprint 40m X 40m for WE			2					2,0	
Average	**2,0**	**1,0**	**2,5**	**2,0**	**3,0**		**2,0**	2,1	2,1
Category V.4 - Risk management									
Factor V.4.1 EIA for first use faciliated EIA for second use			2					2,0	
Factor V.4.2 Proof of concept for future upscaling; reduces project and investment risks			2					2,0	
Factor V.4.3 Although MU may complicate licensing process, it may result in mitigation of negative impacts and simplify asociated EIA process	2							2,0	
Factor V.4.4 Consenting / licensing approach of "deploy and monitor" instead of rigid precautionary principle			2					2,0	
Factor V.4.5 Confluence of appropriate requisite strategic factors coming together to support MU			2					2,0	
Average	**2,0**		**2,0**					2,0	2,0
Category V.5 - Technical added values									
Factor V.5.1 Wave operator shared infrastructure from Aqua. Operator			1					1,0	
Factor V.5.2 Modular space frame technology: flexible, scalable, less space			2					2,0	
Factor V.5.3 Consenting authority "one stop shop"			1					1,0	
Factor V.5.4 Protected bay offers safety assurance for WE technology			1					1,0	
Average			**1,3**					1,3	1,3

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7		
Combination: wave energy and aquaculture	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
NEGATIVE IMPACTS									
Category I.1 - Economic impacts									
Factor I.1.1 Local boat operators supplying diesel generators lose job		1	1					1,0	
Average		**1,0**	**1,0**						1,0
Category I.2. - Social impacts									
Factor I.2.1 Navigation, other users, traffic, constrained by new MU			1					1,0	
Factor I.2.2 Reduced income to local economy			1					1,0	
Average			**1,0**						1,0
Category I.3 - Environmental impacts									
Factor I.3.1 Uncertainty about impacts continues to be a challenge for industry regulators and advisors (TCE, 2015)	3	1						2,0	
Factor I.3.2 Noise impacts and collision risks of marine mammals with wave energy devices or vessels	2		1					1,5	
Factor I.3.3 Biofouling and escapees from aquacutlure; impacts on wild populations (progeny that doesn't survive in habitats)		1		3	3			2,3	
Factor I.3.4 Pollution risk from hydraulic fluid leakage			1					1,0	
Average	**2,5**	**1,0**	**1,0**	**3,0**	3,0			2,1	2,1
Category I.4 - Technical impacts									
Factor I.4.1									
Factor I.4.2									
Factor I.4.3									
Factor I.4.4									
Factor I.4.5									
Average									#DIV/0!
Category I.5 - Policy / Institutional / Licensing									
Factor I.5.1 MU of activities could further complicate licesning process, EIA etc.	3							3,0	
Factor I.5.2 Mus discouraged by Government inconsistency and unpredictability in long-term target and support policies for RE			3					3,0	
Average	**3,0**		**3,0**					3,0	3,0

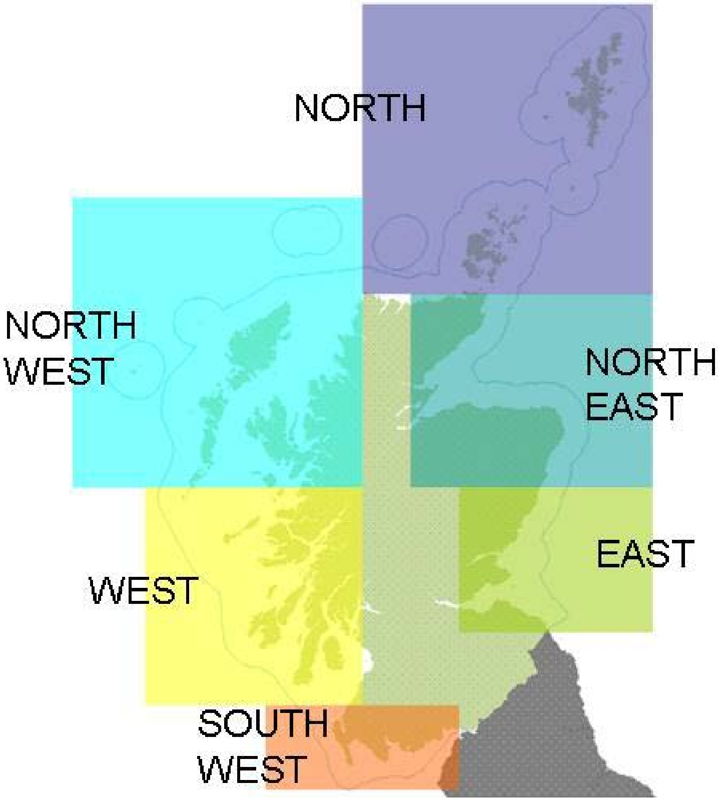
	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8		
Combination: Shipping terminal and Marine Renewable Energy	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
DRIVERS										
Category D.1 - Policy drivers										
D.1.1 MARPOL Annex VI and Global Shipping Industry) set targets for reducing CO2 emissions / air pollution	3	3							3,0	
D.1.2 EU legislation /institutional context [(i) on sulphur content of marine fuels; (ii) 'shoreside electricity facilities as clean power supply'; (iii) monitoring, reporting and verification of CO2 emissions]	3	3	3						3,0	
D.1.3 Policy for investment in offshore marine renewables (Wales and Scotland NMP; Ocean Energy Strat. Roadmap)	2	3		2	2				2,3	
D.1.4 World Port Climate Initiative (WPCI) by many ports to reduce greenhouse gases (GHG), ships to reduce port-related emissions	2		3			3			2,7	
D.1.5 - Ownesrship status of port (usually public, for major industrial EU ports, e.g. Hamburg, Rotterdam, Antwerp)	3	3	3						3,0	
D.1.6 - Government support for public, trust ports	2	3	3						2,7	
D.1.7 - Paris convention for climate change						3			3,0	
D.1.8. - Sub-national marine plans (e.g. Welsh) promote redevelopment for disused ports							1		1,0	
Average	**2,5**	**3,0**	**3,0**	**2,0**	**2,0**	**3,0**	**1,0**			2,4
Category D.2 - Relation with other uses										
D.2.1 - Grid connection of ports can facilitate OW connection	3	3	3	2	2				2,6	
D.2.2- Existing Onshore renewables on ports	1		3						2,0	
D.2.3 - Ports as accomodation for OWF, O& G sector		3	3	3	3			2	2,8	
Average	**2,0**	**3,0**	**3,0**	**2,5**	**2,5**			**2,0**		2,5
Category D.3 - Economic drivers										
D.3.1 - Financial incentives provided to vessels in key ports (e.g. Antwerp)	3	3	3						3,0	
D.3.2 - Investement of major companies to renewable for energy needs (e.g. Nissan)	2		2						2,0	
D.3.3 - Need of PORTS, shipping to reduce fuel consumption, carbon emissions	2	3	2			3			2,5	
D.3.4 - Feed in tarrifs provided to ports for investing in renewable energy projects, incl. SSE	3		2			3			2,7	
D.3.5. - The Crown Estate Scotland interested in co-locating with ports regarding offshore renewable								2	2,0	
D.3.6. - OWF developer incentive to sell electricity generated to end user			3					3		
Average	**2,5**	**3,0**	**2,4**			**3,0**		**2,5**		2,7
Category D.4 - Societal drivers										
D.4.1 - City council energy plans		3	3						3,0	
D.4.2- City council / developers partnerships	2	3	3						2,7	
Average	**2,0**	**3,0**	**3,0**							2,7
Category D.5 Technological										
D.5.1 - OW could be used to provide shoreside electricity	1		1						1,0	
D.5.2 - Certain locations with experience investment in onshore renewables (solar, wind)	1		2						1,5	
D.5.3 - Conversion to SSE could be an asset for certain class / categ. of vessels (e.g. pilot boats, fishing vessels, survey/accomodation vessels for OWF)	1	3	2						2,0	
D.5.4 - Research / technology progress in OW & proximity to coast	2	3							2,5	
Average	**1,3**	**3,0**	**1,7**							2,0
Category D.6 Physical environmnet/ Geographica;										
Factor D.6.1 - Strategic / nodal location of ports as part of energy hub / connection with grid	3	3	3	3	3				3,0	
Average	**3,0**	**3,0**	**3,0**	**3,0**	**3,0**					3,0

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8		
Combination: Shipping terminal and Marine Renewable Energy	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
BARRIERS										
Category B.1 - Legal barriers										
B.1.1 - No IMO leg.	2		2						2,0	
B.1.2 - Ownership status of port	3	2	3	3	3				2,8	
B.1.3 - Crown estate owns Offshore locs not port - complicates licensing	3	3	3						3,0	
Average	**2,7**	**2,5**	**2,7**	**3,0**	**3,0**					2,8
Category B.2 - Administrative barriers										
B.2.1 - Environm plan for ports focused on contamin, dredg, not C.C.,	2	3	1						2,0	
B.2.2 - Staff of enviro oauthorities mainly interested in legal compliance not novel SSE	1								1,0	
B.2.3. Facilitator process needed EU Central, does not exist		2	2			2			2,0	
B.2.4 If interest to OWF development connection, require the lease of seabed from TCE, complicated legislatvie process . Moreover, current leasing system does not know how to adress two activities as MU			2		2			2	2,0	
B.2.5 Absence of guidelines on how to invest in renewables at a port level, attract investors			3						3,0	
Average	**1,5**	**2,5**	**2,0**		**2,0**	**2,0**		**2,0**		2,0
Category B.3 - Barriers related with economic availability / risk										
B.3.1 - Private owner port not willing to co-locate	3	3							3,0	
B.3.2 - Port dependent on O&G cannot readily diversify	1	3							2,0	
B.3.3 - Solar, land-based solutions, LNG championed	0		2						1,0	
B.3.4 - onshore wind cheaper	3	3	3						3,0	
B.3.5 - huge investment to convert vessels to SSE compatible	3		2						2,5	
B.3.6 - Other sources, including non-enewables, more viable and cost effective (also renewables, e.g. LNG) championed etc.	3					3			3,0	
B.3.7 - Route of vessel, level of activity	1		3						2,0	
B.3.8 - No funds for such activity	3								3,0	
B.3.9 - Uncertainty development- Large drop in Feed In Tarrifs for renewable energy - change in power provision scheme from company to port	3		3						3,0	
B.3.10 - Competition with other (also non-EU countries) ports. Vessels will shift activity there					3	3			3,0	
B.3.11 -Subsidisation and cabling system - unclar who is to fund these; access to grid may be prohibitive in rural areas						2		3	2,5	
Average	**2,2**	**3,0**	**2,6**		**3,0**	**2,7**		**3,0**		2,7
Category B.4 - Barriers related with technical capacity										
B.4.1 - Scale of port, type vessels accomodated		3	3						3,0	
B.4.2 - OW energy transmission and storage in port	2		3						2,5	
B.4.3 - Huge energy requirements to fuel vessels	3								3,0	
B.4.4 - Renewables energy fluctuations - unsteady supply	3		3						3,0	
B.4.5 - Class and size of vesssels (e.g. cruise ships) too expensive to convert engine	3		3						3,0	
B.4.6 - Type of vesssels - not possible to convert to SSE (e.g. tankers, cargo)	3								3,0	
B.4.7 - Position of vessel relative to port / Space of port	3		3						3,0	
B.4.8 - Infrastructure of port to implement SSE	3	3	3						3,0	
B.4.9- No net gain anticipated for SSE investment	3								3,0	
Average	**2,9**	**3,0**	**3,0**							3,0
Category B.5 - Barriers related with social factors										
B.5.1 Dredging interactions	3	3							3,0	
B.5.2 Interactions with shipping lanes, impacts of port traffic	3	3			3				3,0	
B.5.3 Visual impact of OWF	1		2						1,5	
B.5.3 Impcts on fisheries from OWF					2				2,0	
Average	**2,3**	**3,0**	**2,0**		**2,5**					2,5
Category B.6 - Barriers related with environmental factors										
Factor B.6.1 Depth of port		3							3,0	
Factor B.6.2 Sheltered environmenta - wind availability	3	2	2						2,3	
Factor B.6.3 wind fluctuation	3	2	2						2,3	
Factor B.6.4 Corosion - salt-water environment			2						2,0	
Average	**3,0**	**2,3**	**2,0**							2,4

Combination: Shipping terminal and Marine Renewable Energy	Interviewee 1 Score	Interviewee 2 Score	Interviewee 3 Score	Interviewee 4 Score	Interviewee 5 Score	Interviewee 6 Score	Interviewee 7 Score	Interviewee 8 Score	Factor average for all stakeholders	Category average (average of all factors averaged for all stakeholders)
ADDED VALUES										
Category V.1 - Economic added values										
V.1.1 Ports could serve as infrastructure for OWF	1		3			3			2,3	
V.1.2 SSE could be implemented in marinas, not solely SSEs		2							2,0	
V.1.3 Decline in grid energy demands due to invest in own renewable energy sources			3						3,0	
Average	**1,0**	**2,0**	**3,0**			**3,0**				2,3
Category V.2 - Societal added values										
V.2.1 New employment opportuniteis, especially in rural areas	3					2	3		2,7	
V.2.2 Community engagemnet, education, public outreach by investment in green / renewable energy		2	2			2		2	2,0	
V.2.3 For highly industrial ports, OW and shipping industry will have small visual impact and may be perceived positively by residents	1								1,0	
V.2.4 Prices of eco-port (British Port Association) prestigious for port to be included			2						2,0	
Average	**2,0**	**2,0**	**2,0**			**2,0**	**3,0**	**2,0**		2,2
Category V.3 - Environmental added values										
V.3.1 Reduction in GHG, especially in emission hotpsots that ports frequently are located			3			3			3,0	
Average			**3,0**			**3,0**				3,0
Category V.4 - Better ensurance policy and risk management										
V.4.1 Developers anticipate legislation to become progresivelly more stickt and require SSE	2								2,0	
Average	**2,0**									2,0
Category V.5 - Technical added values										
Factor V.5.1 Especially for rural areas away from major energy and infrastructure hubs, development provides direct access to energy generation and infrastructure.		3		3	3				3,0	
Average		**3,0**		**3,0**	**3,0**					3,0

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6	Interviewee 7	Interviewee 8		
Combination: Shipping terminal and Marine Renewable Energy	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Factor average for all stakeholders**	**Category average (average of all factors averaged for all stakeholders)**
NEGATIVE IMPACTS										
Category I.1 - Economic impacts										
I.1.1										
I.1.2										
I.1.3										
I.1.4										
I.1.5										
Average										
Category I.2. - Social impacts										
I.2.1 Impacts on navigation, shipping lanes	1	3			3				2,3	
I.2.2 LAC might object visual impacts of OWF	3								3,0	
I.2.1 Impacts on sailing, recreation		2							2,0	
I.2.4 Impacts on fisheries					3				3,0	
I.2.5										
Average	**2,0**	**2,5**			**3,0**					2,5
Category I.3 - Environmental impacts										
I.3.1 Noise and impacts on marine mammals during construction	3	2							2,5	
I.3.1 Noise and impacts on birds from OWF (close to land)	3								3,0	
Average	**3,0**	**2,0**								2,5
Category I.4 - Technical impacts										
Factor I.4.1										
Factor I.4.2										
Factor I.4.3										
Factor I.4.4										
Factor I.4.5										
Average										

APPENDIX 2 - SCOTTISH OFFSHORE RENEWABLE ENERGY REGIONS (SORERS) (AFTER: THE SCOTTISH GOVERNMENT, 2013)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

APPENDIX 3 - LIST OF STAKEHOLDERS

MU wave and aquaculture; MU Offshore wind, wave and aquaculture

Stakeholder* (Name of org.)	Short description (role and competence)	Relevance for MU*	Selection method (e.g. nominated, past project)	Form of interview or other engagement method (tel., in person, other)	Why interview was conducted
Commercial developer	Offshore energy	Commercial business and intermediary (energy fora)	Past project	Tel	Key stakeholder, DABI for key MU
Regulator	Aquaculture, maritime planning	Cross sector	Nominated	In person	Key stakeholder, DABI for key MUs
Commercial developer	Aquaculture developer	Commercial business	Past project	In person	Key stakeholder, DABI for key MUs
Commercial developer	Wave developer	Commercial business	Past project	In person	Key stakeholder, DABI for key MUs
Policy maker	Maritime planning, offshore renewable energy	Cross sector	Past project	In person	Key stakeholder, DABI for key MUs
Regulator	Marine/maritime activities; leasing/licensing	Cross sector and commercial business	Nominated	In person	Key stakeholder, DABI for key MUs
Regulator	Marine/maritime activities; leasing/licensing	Cross sector and commercial business	Nominated	In person	Key stakeholder, DABI for key MUs

*** Information has been provided based on level of anonymity required by stakeholders in order to prevent them being identified.**

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MU shipping terminal and green energy

Stakeholder* (Name of org.)	Short description (role and competence)	Relevance for MU*	Selection method (e.g. nominated, past project)	Form of interview or other engagement method (tel., in person, other)	Why interview was conducted
Policy maker	Maritime planning, offshore renewable energy	Cross sector	Nominated	In person	Key stakeholder, DABI for key MUs
Policy maker	Maritime planning, offshore renewable energy	Cross sector	Nominated	In person	Key stakeholder, DABI for key MUs
Commercial developer	Port developer / Harbour authority (trust)	Commercial business	Desk research	In person	Key stakeholder, DABI for key MUs
Commercial developer	Port developer / Harbour authority (private)	Commercial business	Nominated	In person	Key stakeholder, DABI for key MUs
Regulator	Marine/maritime activities; leasing/licensing	Cross sector and commercial business	Nominated	In person	Key stakeholder, DABI for key MUs
Regulator	Marine/maritime activities; leasing/licensing	Cross sector and commercial business	Nominated	In person	Key stakeholder, DABI for key MUs
Society representative	Local council	Cross sector and commercial business	Nominated	In person	Key stakeholder, DABI for key MUs

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