GUIDANCE FOR COMMUNITIES ON THE DEVELOPMENT OF WAVE AND TIDAL PROJECTS

ISLAY ENERGY TRUST
NATURAL POWER CONSULTANTS

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Report
Guidance for Communities on the Development of Wave and Tidal Projects

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E	9th September 2013	Minor revisions for publication

FOREWORD

Guidance for Communities on the Development of Wave and Tidal Energy Projects

Foreword by Fergus Ewing Minister for Energy, Enterprise and Tourism

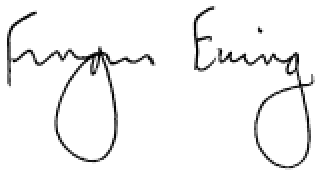
The Scottish Government is keen to ensure that local communities share in the benefits from our natural energy resources and we have a strong track record of supporting communities to get involved in onshore renewables projects.

Scotland is also leading the way in its support for and promotion of the wave and tidal energy sector. But this sector is still in its infancy and, compared to more established technologies like onshore wind and hydro, it is riskier and more expensive, with any net returns only accruing in the longer term.

We are aware however of growing interest from coastal communities to get directly involved in this area in order to build long-term local sustainability. We recognise this ambition and want to ensure that our coastal communities are ready and able to grasp opportunities as the wave and tidal energy sector develops.

This guidance, funded under our Community and Renewable Energy Scheme (CARES), aims to help communities to understand the process by which they may identify local marine energy opportunities, and assess the scope for development. The document gives an overview of the tidal and wave energy technologies and the process and considerations that form part of the feasibility and predevelopment stages of a scheme. Without underestimating the scale of the challenge, it provides a template for engagement.

We are at the start of a marine energy revolution and this guidance will help to ensure that our coastal communities are part of that movement.



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1. EXECUTIVE SUMMARY

Islay Energy Trust (IET), Natural Power Consultants (Natural Power) have produced a guide to assist coastal communities in the development of wave and tidal projects around Scotland. It has been fundied from Scottish Government Community and Renewable Energy Scheme (CARES).

The Scottish Government is committed to the development of community renewable projects. They have clearly stated that they wish to maximise the benefits from renewable energy for communities, both in direct energy and financial benefits as well as local regeneration and skills development.

There are a range of potential benefits for communities involved with the development of wave and tidal developments. These include revenue streams, economic development and development of local businesses, infrastructure, skills and job creation, community cohesion and development precedent. However, a central difference between community marine energy projects and conventional commercial developments is the opportunity to secure socio-economic as well as financial benefits in the eventual operation of any project.

While using this guide, it is important to understand that the wave and tidal industry is an embryonic industry with high costs and higher risks in comparison with more conventional types of renewable energy. While this report is applicable to wave and tidal developments the content as with regards to community development is biased towards tidal projects.

The guide provides advice and recommendations on the process of developing a project from concept, through a feasibility study, and successfully gaining the leases, licences and consents required. It offers detailed guidance on the topics to consider at feasibility stage and signposts to publically available information. An overview of the consenting and licensing process is given, as well as advice on resource assessment, device selection criteria, finance and funding. A section dedicated to ports, vessels, supply chain and socioeconomics has been supplied by SeaRoc Ltd.

It is hoped that this guide equips and informs coastal communities who are considering the development of, or investment in, a wave or tidal project. While not covering in detail every aspect of a community development, the guide aims to provide an overview of topics to consider, investigate and discuss, and a reference section is provided to direct towards other publically available information sources.

2. INTRODUCTION

2.1 Scope

Islay Energy Trust (IET), Natural Power Consultants (Natural Powerwith funding from SG CARES have produced this report to assist coastal communities in the development of wave and tidal projects around Scotland.

The document aims to provide a simple, clearly worded guidance document for coastal community who are considering the development or investment in a wave or tidal project. It focuses primarily on the model of community led developments; however some content is also applicable to the model of community equity investments in wave or tidal schemes.

While using this guide, it is important to understand that the wave and tidal industry is an embryonic industry with high costs and higher risks in comparison with more conventional types of renewable energy. While the wave and tidal industries are commonly grouped as one, there are a number of subtle differences. Tidal energy has the benefit of familiarity ('looks like a wind turbine') a converging consensus on technology, generation predictability and easier site access (although near shore wave benefits from this) (ReUK, 2013). Tidal energy, at this time, also shows a greater degree of scalability with a range of device sizes offering access to energy resources in sheltered locations. Wave energy, by its nature, requires sites located in more exposed locations, necessitating a larger scale of device and project. While this report is applicable to wave and tidal developments the content as with regards to community development is biased towards tidal projects.

There is a wide range of information available in the public domain providing guidance on consenting, environmental issues, high level constraints analysis and finance. This document does not seek to replicate that advice, rather to clearly sign post the relevant reports and information sources and provide a route to consent application. It is recognised that the wave and tidal industry is a fast developing one, and information in the public domain may quickly become out of date as the industry grows. Please note that all website addresses were last accessed in March 2013.

In summary, the document covers the following aspects of wave and tidal projects:

- Stages of development of a wave or tidal project from concept to consent, covering key topics and constraints;
- Public domain resources and sources of information;
- Technology categories;
- Socioeconomic, supply chain, vessel and port considerations;
- Consideration of finance and funding.

2.2 Contributors

2.2.1 Islay Energy Trust (IET)

IET is a community-owned charitable company whose purpose is to develop and operate renewable energy projects for community benefit whilst reducing Islay's carbon footprint. IET is well equipped to pioneer the development of community participation in tidal and wave energy projects, either as leader or joint venture participant or service provider. In 2008, it completed its own pre-feasibility study with the assistance of The Robert Gordon University into tidal energy in the Sound of Islay, and that led to the agreement for IET to provide local services to Scottish Power Renewables for its 10MW Sound of Islay Tidal Energy Project, which received Scottish Government consent in 2011, with deployment of devices scheduled for 2015/16. This will be one of the first arrays of tidal devices world-wide. It is now conducting a feasibility study into a community-led tidal project in the seas around Islay.

2.2.2 Natural Power Consultants

Natural Power (NP) is an independent consultancy with over 15 years of in-house experience of the onshore and offshore renewable energy development and operations life-cycle. This spans site prospecting, resource assessment and feasibility, through design, consent and construction to operational asset management.

NP is a pioneer in bringing new technologies, methodologies and best practices to the forefront of the industry in order to tackle our clients' most complex and challenging issues.

Kay achievements to date include:

- 250 renewable energy experts, 12 locations in UK, France and US covering onshore wind, offshore wind, wave, tidal, biomass and hydro.
- 2,100 MW of client projects consented.
- Construction management on 1,000 MW of wind plant.
- Ongoing operational services on more than 2.000 MW wind farms including 200 MW offshore.
- 25,000 MW due diligence / resource assessment services.

The above has given NP extensive experience within the offshore industry, covering wave, tidal and wind. We therefore have considerable experience of feasibility studies, technology reviews, EIA management, ecology surveys and resource assessments which can applied to both small scale marine projects for both community based clients and device developers, as well as large scale projects.

2.2.3 SeaRoc

SeaRoc is a technology developer, marine consultancy firm and installation contractor which provides specialist products and services to the Offshore Renewable Energy Sector. They offer clients marine, engineering, quality, health, safety and environment (QHSE) and geographical information system (GIS) data management expertise. SeaRoc has a range of bespoke applications that support the lifecycle of offshore projects. They address the challenges that the marine environment presents to project stakeholders which have significant QHSE and commercial impacts and require experienced planning, management and onsite co-ordination.

SeaRoc supports a variety of client companies on a wide range of offshore wind, tidal and wave energy projects. They have been involved from site selection through development and construction, into operations and maintenance on a large number of UK projects, as well as an increasing number of North European, North American and Asia Pacific projects.

3. WAVE AND TIDAL ENERGY

As a seafaring nation Scotland is surrounded by open waters of potentially exploitable energy resource. The most familiar method of energy extraction is through the offshore wind turbine; however the water itself contains harvestable energy in the form of wave and tidal energy.

Images used in the following section are courtesy of Aquatic Renewable Energy Technologies (Aqua-RET) and European Marine Energy Centre (EMEC).

3.1 Wave Energy

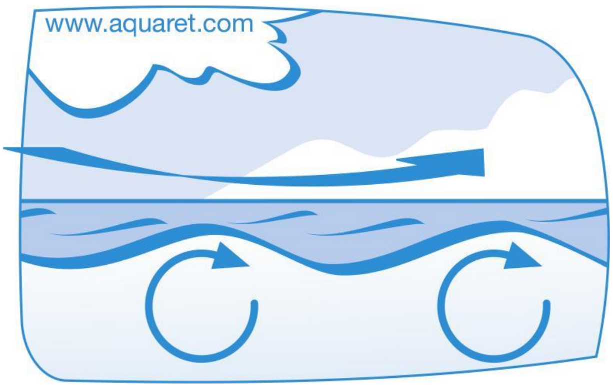

Figure 1: Winds blowing over the sea generate waves

The wave energy in Scotland's seas is developed through the prevailing westerly winds, which maintain our warm climate, blowing over the Atlantic and causing the generation of the waves that daily arrive on our coastline, Figure 1. As the best wave resources are located where strong winds blow across large stretches of open water Scotland has some of the best wave resources in the world, Figure 2. The energy in the waves is held in their height and the distance between their crests in the form of kinetic and potential energy. The difference between the top and bottom of the wave can be used to drive pumps and generators. The difference in wave length can be used to push and pull fixed objects to in turn generate power.

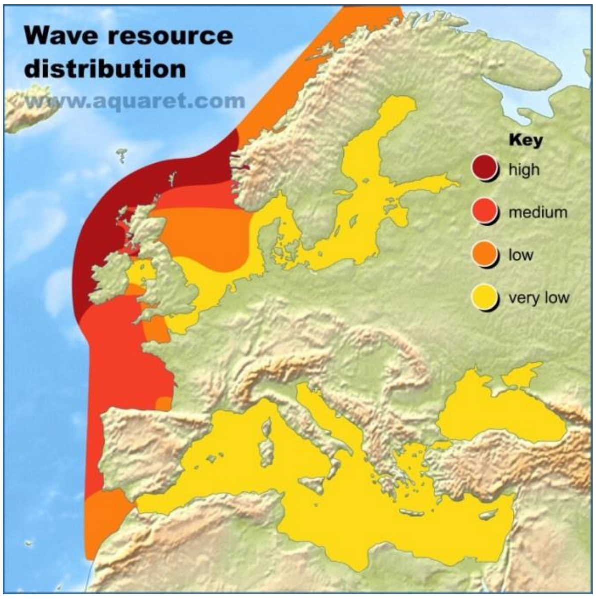

Figure 2: Wave energy resources around Europe

3.2 Wave Technology

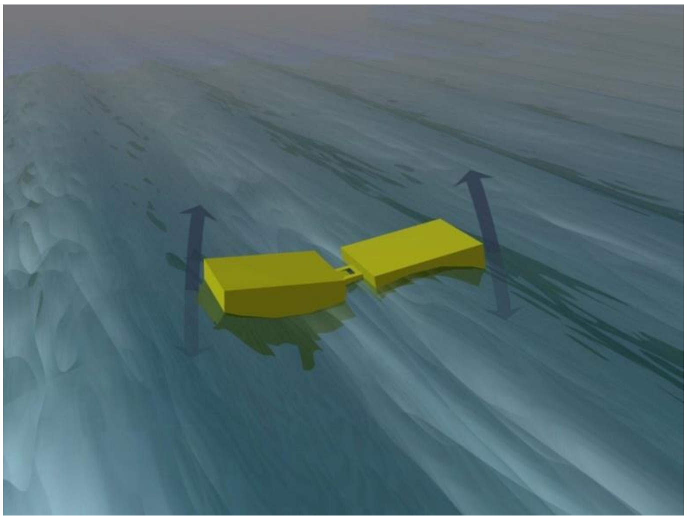

Figure 3: Attenuator device

3.2.1 Offshore Wave Devices

Offshore wave devices generate power from the relative motion of two or more floating parts commonly joined by hydraulic rams. As the wave causes one part to move up the other will move down alternatively pushing and pulling on the hydraulic system, Figure 3. An alternative configuration, the point absorber, holds one the parts steady by attachment to the seabed or effective fixed point, Figure 4. The height of wave determines the distance that the parts will move and therefore the potential to move the hydraulic system. Water depths greater than 50m are generally required for these types of system. Offshore devices tend to generate electricity within the device requiring subsea cables to shore.

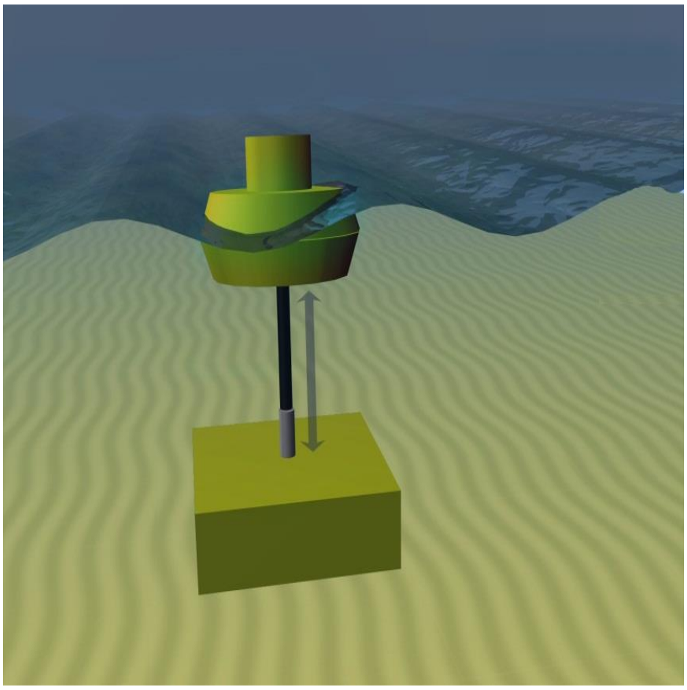

Figure 4: Point absorber device

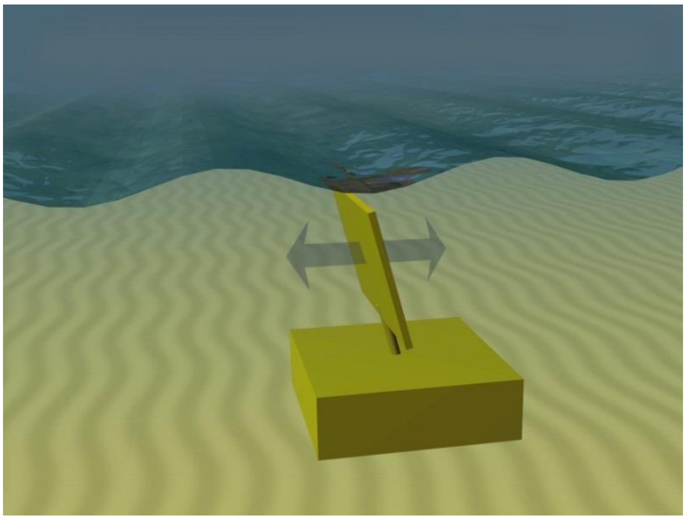

Figure 5: Surge wave converter

3.2.2 Nearshore Wave devices

Nearshore devices generate energy from waves close to shore in less than 20m water depth. These devices are commonly fixed to the seabed. The motion of the wave causes the movement of the device relative to the seabed. Surge wave converters are based on the device being fixed at the seabed and the to and fro motion of the wave being used to move the floating section, Figure 5. Pressure differential devices use the height/weight of the wave to push down or draw up the devices floating section located below the water surface, Figure 6. With nearshore devices the height of the wave and the distance between the peaks cause the devices to drive hydraulic systems. Nearshore devices can generate electricity directly or be used to pump fluid to shore under high pressure for use in a conventional hydro-electrical generator.

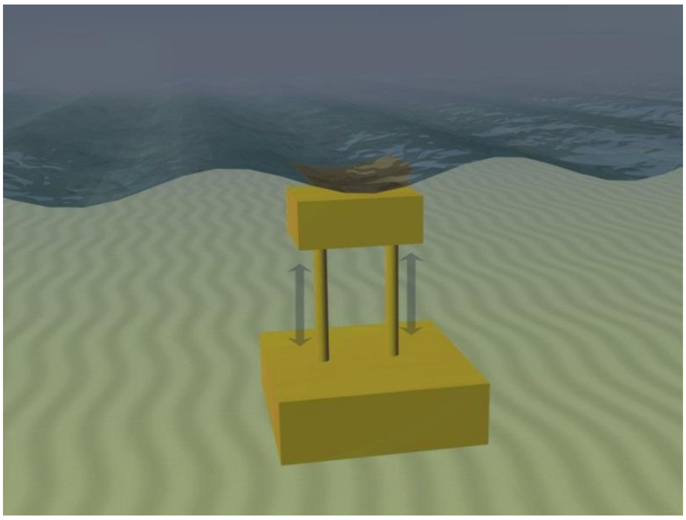

Figure 6: Pressure differential device

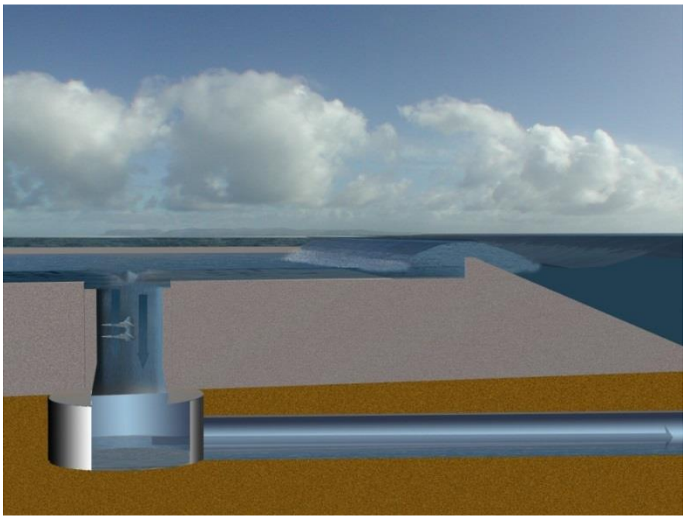

Figure 7: Overtopping device

3.2.3 Shoreline Wave devices

Shoreline devices are built into the shoreline or as part of a breakwater and can be classed as overtopping or as oscillating water columns. Overtopping devices capture part of the wave arriving at the shoreline in a raised pond to be released through a hydro-electric generator, Figure 7. Oscillating water columns are enclosed chambers into which the arriving wave forces air; the pressurised air being used to turn a generator, Figure 8.

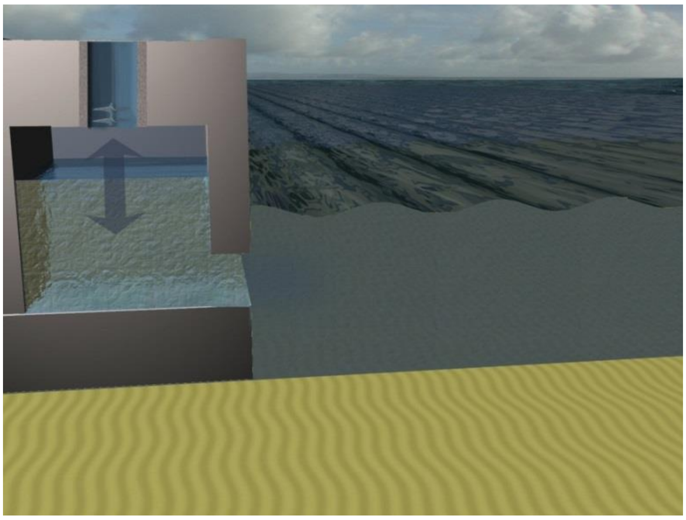

Figure 8: Oscillating water column

3.2.4 Alternative concepts

In addition to the device categories given above there are several technologies which do not fall easily within these descriptions. As the wave industry has not, to date, converged on a fixed energy extraction method more technologies will become available. EMEC's website[1] should be consulted for a full list of technology categories and device manufacturers.

[1] http://www.emec.org.uk/marine-energy/wave-developers/

3.3 Tidal Energy

The tidal energy in Scotland's waters is developed from the very high tides that we experience at our coast. The tides are a result of the Sun and Moon pulling on the waters within the world's oceans, Figure 9 (left image).

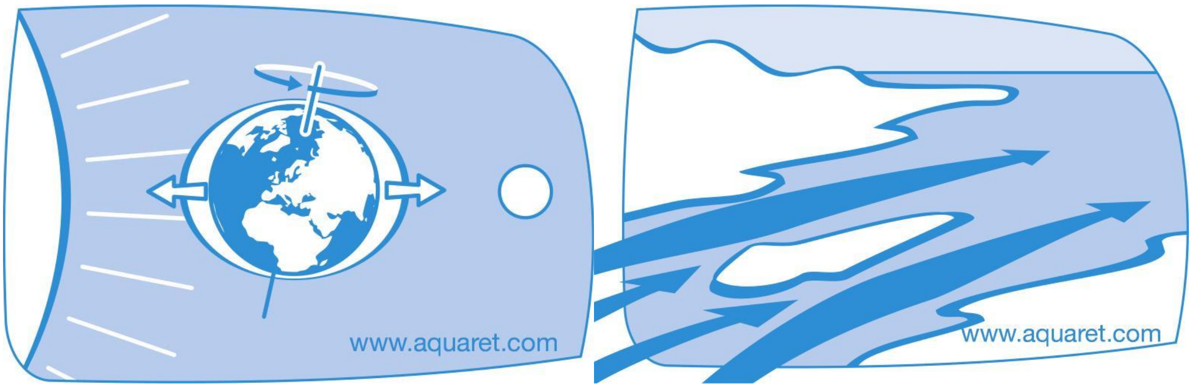

Figure 9: Tidal elevations generated by the moon and sun and high velocities through channels

This is commonly seen as the daily high and low tide, with large spring tides occurring twice a month. As large volumes of water generated by the daily tides move into and out of the Irish Sea and North Sea they must pass through channels between our islands or around headlands, Figure 9 (right image). As the water is squeezed through these areas it speeds up to a point where the energy can be captured by bladed turbines. As Scotland is located where the oceans tides must move from the Atlantic into the North Sea very fast tidal streams are found around Shetland, Orkney and Inner Hebrides, Figure 10.

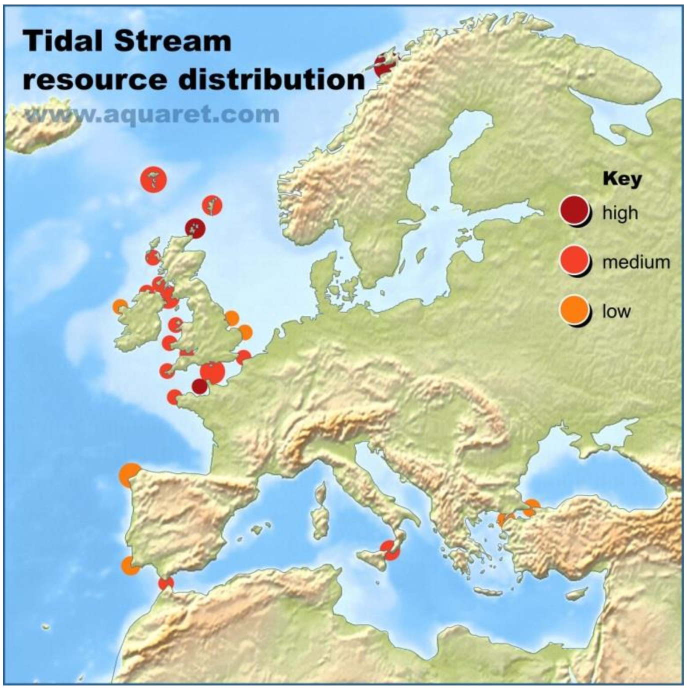

Figure 10: Tidal stream resources around Europe

3.4 Tidal Technology

3.4.1 Horizontal Axis Tidal Turbines

Horizontal axis tidal turbines are very similar to existing wind turbines with shorter, stockier blades and robust towers, Figure 11.

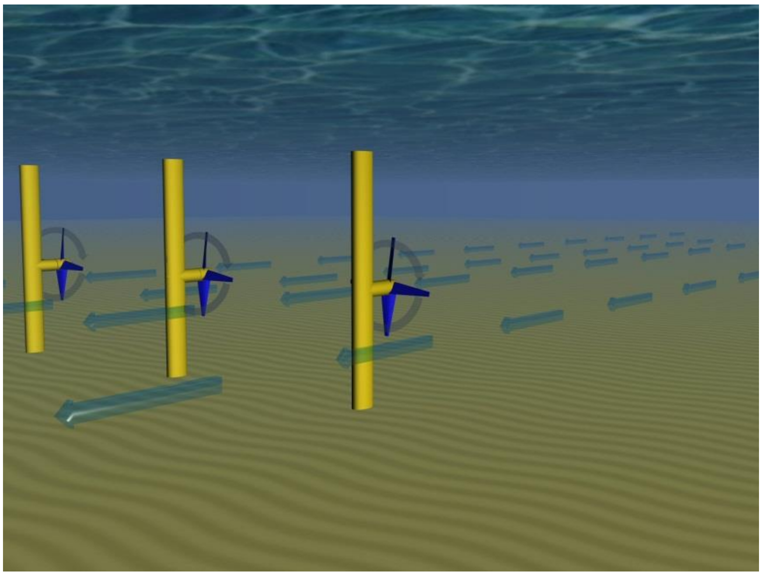

Figure 11: Horizontal axis turbines on seabed piles

The turbines can either be seabed mounted or suspended in the water column (from a floating structure or moored to the seabed). Devices where some infrastructure penetrates the sea surface, for maintenance or as part of the engineering design, as known as 'surface piercing'. The velocity of the tide flowing past the turbine causes a lift force to be generated by the blades; which in profile look similar to an aircraft wing. The lift force generated by the blade causes it to turn. The blades are attached to a generator which turns to produce electrical power. This power is taken to shore by means of an electrical cable.

3.4.2 Vertical Axis Tidal Turbines

Vertical axis turbines are based on the same lift force generated across a blade as described for the horizontal axis turbine. In this case the generator being turned is typically located at or above the sea surface with the blades acting like a revolving door.

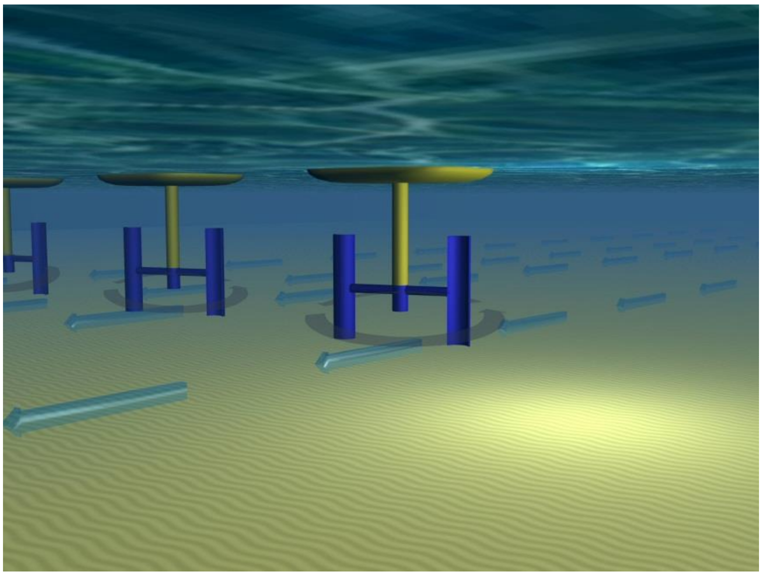

Figure 12: Vertical axis turbines on floating support

3.4.1 Alternative Concepts

As with wave energy technologies the field of tidal energy is constantly producing new device designs. As such it is recommended that interested parties visit the EMEC website[2] to gain an overview of all concepts.

[2] http://www.emec.org.uk/marine-energy/tidal-developers/

4. CONTEXT FOR WAVE AND TIDAL DEVELOPMENTS

4.1 National Context and Support for Community Renewable Energy Developments

Renewable energy development in Scotland has a strong support mechanism and a streamlined planning framework. UK wide support is evident through wide spread public sector funding focussed on supporting manufacturers and developers and support for test centres in Orkney (EMEC), Cornwall (Wave Hub) and north east England (NaREC). The UK Government has made clear it's commitment to increasing deployment of renewable energy across the UK (DECC, 2011). The wave and tidal sector has attracted particularly strong support with five ROCs (Renewable Obligation Certificates; refer to Section 9.1 for further information) and increasing investment.

The Scottish Government is committed to the development of community renewable projects and has set a target of 500MW of community and locally-owned renewable energy capacity by 2020 (Scottish Government, 2011b). Support to achieve this aim is available in a range of programmes including CARES, REIF and the Coastal Communities Fund (Section 9.2). The Scottish Government has clearly stated that it wishes to maximise the benefits from renewable energy for communities, both in direct energy and financial benefits as well as local regeneration and skills development. Indeed, Scottish Planning Policy states:

"There is potential for communities and small businesses in urban and rural areas to invest in ownership of renewable energy projects or to develop their own projects for local benefit. Planning authorities should support communities and small businesses in developing such initiatives in an environmentally acceptable way." (Scottish Government, 2010)

4.2 Models for Community Involvement

The involvement of local communities in renewable energy projects can provide both financial and economic development benefits whilst building on the links between the community and the physical environment around it.

Community involvement in renewable energy schemes traditionally falls within three categories, each requiring varying commitment, risk and benefit:

1. Community benefit schemes, i.e. a private developer provides an annual payment to communities in the vicinity of the development;
2. Equity share, i.e. to buy into a project lead by a private developer;
3. Community led developments i.e. a project lead by the community as a full or majority owner.

The content of this report focuses on the third model. Analysis undertaken in Shetland on the Viking Wind Farm (Allan et al, 2008) suggests that positive benefits from community benefit schemes are modest relative to those that could be secured from any shared-ownership scheme. However, community groups should consider all options available to them to determine the best fit with their aims, funding and risk profiles.

It should be noted that although community benefit schemes are common place in the renewables industry, particularly for onshore wind developments, there is no obligation on developers to offer such a scheme. However, some funders may require payment of community benefit funds as part of a project.

A number of case studies are provided in Appendix 3: Case Studies.

4.3 Community Wave and Tidal Energy Projects

There is a strong track record of the involvement of communities in onshore wind projects. The technology is mature, the development process is well-defined, and costs, revenues and risks are understood.

In contrast, wave and tidal energy is at an early stage of development. The technology is still evolving, the costs are not clear and the marine environment is more challenging than onshore. Whilst community wave and tidal energy projects have the potential to generate revenue in the longer term, one of the main current benefits for a coastal community of initiating a project is the potential for economic development as local businesses become in involved in the development of a new industry.

4.4 High Level Challenges and Risks

As with any renewables development, the consenting, installation and operation of a wave or tidal scheme has inherent challenges, which should be considered carefully by communities. Many of these challenges reflect the early stage of the industry and as discussed above, there are other forms of renewable energy that represent less challenging and lower risk opportunities for communities. At a high level, challenges in relation to wave and tidal development are described in Table 1.

Table 1: Challenges for wave and tidal development

Costs	Potentially, initially high development costs in comparison with other renewable technologies due to technology development, remote and harsh conditions at deployment locations and grid connection.
Technology	Availability of accredited and appropriate technologies.
Finance	Availability of project finance (i.e. investment secured on income from the project), given early stage of industry.
Commercial confidentiality	Issues surrounding commercial confidentiality and availability of data at an early stage of site development.
Lease and License/consent	Application for a Crown Estate seabed lease and appropriate licences to deploy.
Grid	Availability and cost of grid connection.
Operations	Risks and unknowns associated with operational period.
Insurance	Insurance requirements which may be stringent and expensive.
Timescales	Timescales from feasibility to operation of a scheme.

While the risks above are common to commercial developers and community groups, acceptable risk profiles and available mitigation measures may differ (ie access to finance, resources, expert opinion etc). This report provides further information on some of the above risks in the context of a community wave or tidal development to allow coastal communities to make informed decisions.

4.5 Potential Benefits for Communities

The Scottish Government and its agencies support communities to secure the ownership, management and benefits of renewable energy projects (Scottish Government, 2011b). Given the risks and challenges associated with the development of wave and tidal projects, it is important to highlight the potential benefits to a community beyond a simple model of community benefit, as discussed in Table 2.

Table 2: Potential benefits for communities

Revenue	Economic benefit through long term returns on investment.
Employment	Local jobs and supply chain support (infrastructure, boats, contractors, servicing facilities etc).
Economic Development	Opportunity for local businesses to develop in a new and growing market.
Indirect Benefits	Secondary benefits such as accommodation, services, tourism etc.
Local Resources	Provide an opportunity for communities to capitalise on local resources.
Local Knowledge	Provide an opportunity to utilise significant local knowledge of an area for the benefit of a community –a coastal community will have an in-depth knowledge of their local land and seas, including tidal resource, seabed conditions, fisheries, navigation concerns, local ecological communities etc which is invaluable to early stages of development.
Skills development	Development of skills in the local community, both new and transferable.
Community cohesion	Provide a new, sustainable lease of life for coastal communities, and potential for increased community cohesion.
Development precedent	Opportunity to engage with, and influence an industry, and potentially to influence the development in a way which increases community benefits.

It is clear these benefits should be balanced carefully against the challenges and risks outlined above throughout the investigation, feasibility and development stages of a community wave or tidal project. Indeed, communities may wish to carry out exploratory work, allowing them at an early stage to communicate their wish for involvement in any future wave or tidal development once the industry has matured.

5. STAGES OF DEVELOPMENT TO CONSENT

5.1 Overview

The lifetime of a renewable energy development can be split into four phases as shown in Figure 13. As illustrated, from conception to commissioning of the device in the water may take five years, however this is highly dependent on a range of factors including access to funding, EIA and consenting timescales, grid connection dates, availability of technology and infrastructure, and long term economics of the development . The project phases include:

- Phase 1A/1B: Feasibility assessment, technology assessment, lease application, Environmental Impact Assessment and application for consent/licence.
- Phase 2: Investment, device procurement, assembly, site preparation, installation and commissioning.
- Phase 3: Operation and maintenance.
- Phase 4: Decommissioning.

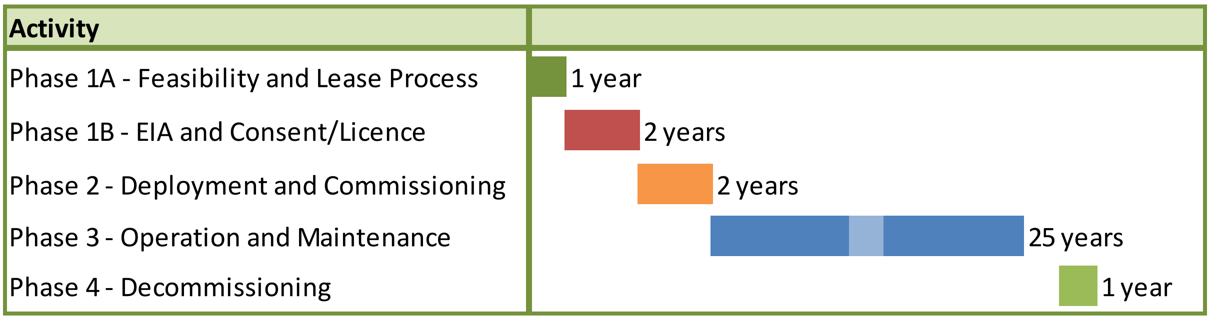

Figure 13: Indicative lifetime of a wave or tidal project

This section of the guidance document provides a summary of the feasibility and consenting process (Phase 1A/1B above): the process from initial conception to consent can be lengthy (three years or more), involved and often costly. An overview flow diagram is provided below in Figure 14.

While this guidance focuses on pre-consent stages, communities should consider long term aims of the project including ownership, construction, operation and maintenance strategies, decommissioning and financing.

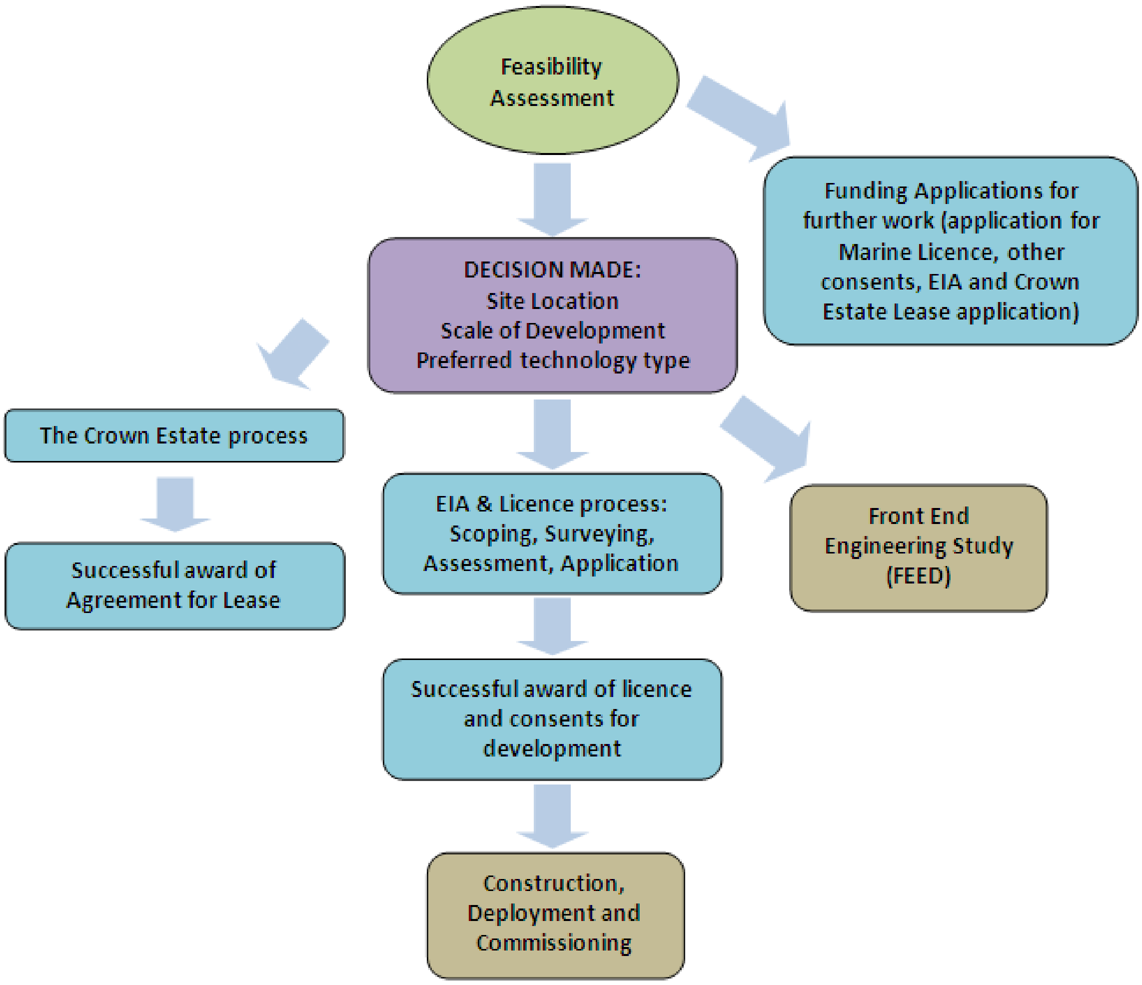

Figure 14: Overview of stages from feasibility (Phase 1a) to deployment and commissioning (Phase 2)

5.2 Feasibility Assessment

5.2.1 Aims of a Feasibility Process

It is recommended that community groups considering a wave or tidal development undertake a thorough and considered feasibility study at an early stage in order to minimise risks associated with development (financial, organisational, technical etc). A feasibility study, properly documented, should provide a basis for factual and informed community discussion and decision making. Time and money spent at this stage can reduce risks and expense later in the development process.

The aim of any feasibility assessment should be to characterise the site at a high level including gathering information on resource, constraints, highlight any showstoppers or high risks, and to define the site, scale and ambition of the development. It should be based on fact and expert opinion, and upon completion act as a milestone enabling the community to decide if to progress further with the scheme or to consider alternatives. Information gathered during the feasibility assessment will also a sound basis for pre-screening discussions with regulators, any application to the Crown Estate and subsequent progression through the EIA process.

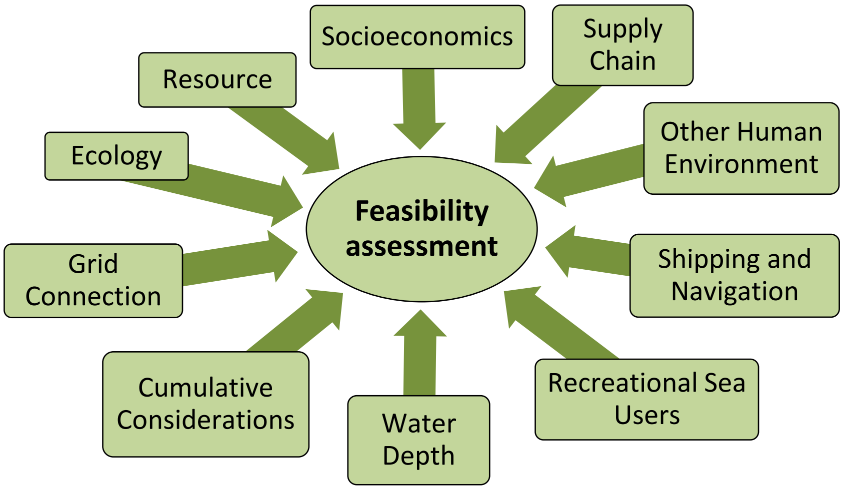

Figure 15: Considerations in a feasibility assessment

Much of the information for a feasibility assessment can be gathered from publically available documents, local knowledge and the expert opinion of professionals. Figure 15 provides a summary of the topics to be considered during feasibility and further information is provided below, ordered of influence on site selection. However every site is different and it should be noted that considerations that have been awarded lesser weighting in the list below, may actually carry a heavy influence depending on the site under consideration. It is advised that any decision making process should consider all the aspects below in combination with financial considerations and long term aims for the scheme.

5.2.2 Resource

At a fundamental level, wave and tidal devices require an energy resource to provide power; therefore resource levels will drive the feasibility assessment and have therefore been given highest weighting. The UK possesses a considerable wave and tidal energy resource that is well documented at a regional scale (BERR, 2008), with some of the best resources located off the west and north coasts, as shown in Figure 16 and Figure 17 below. Scotland has an estimated 10% of Europe's wave power and 25% of tidal power.

Assessment of resource should constitute the first step in the assessment of feasibility of any project. The size and location of the resource in turn will influence the device selection, scale of development and the overall aspirations of the community development. The resource levels required for successful commercial deployment will depend on the device design and rating. Broadly, the minimum tidal stream speed required for a tidal energy deployment is ~6m/s. For wave deployment, a minimum of ~20kW/m is required. It should be noted that resource levels documented in publically available reports may not have sufficient resolution to detail small pockets of resource within the overall identified resource area, in particular pockets which may be suitable for <1MW scale deployments. Expert opinion should be sought in these instances as well as gathering of local knowledge. A number of publically available resources provide high level resource maps. These and local navigation charts, tide tables, sailing pilots should be referred to at the outset of any project.

PUBLICALLY AVAILABLE RESOURCES FOR RESOURCE MAPPING

BERR, 2008. "Atlas of UK Marine Renewable Energy Resources. 2008. ABPmer[3]. Main resource and provides data in GIS format and can be downloaded.

Scottish Executive, 2007. 'Strategic Environmental Assessment (SEA)'[4] provides data on most appropriate and best locations to place wave and tidal devices.

Marine Scotland Science, 2010. 'Regional Locational Guidance' (2010)[5], in support of the Saltire Prize Programme, details areas of Scotland's seas considered most appropriate for development of wave and tidal energy.

Scottish Government, 2011a, 'Scotland's Marine Atlas: Information for the National Marine Plan' [6]

Carbon Trust, June 2011b, 'UK Tidal Current Resource & Economics' [7]

Carbon Trust, Oct 2012, 'UK Wave energy resource report' [8]

In addition to the public documents referenced above there may exist, for specific locations, academic studies carried out by university departments. Enquiries may be made at University of Edinburgh, Herriot-Watt University, University of Exeter or Environmental Research Institute in the first instance where they may be directed to the relevant contacts.

[3] http://www.renewables-atlas.info/
[4] http://www.scotland.gov.uk/Topics/marine/marineenergy/wave/WaveTidalSEA)
[5] http://www.scotland.gov.uk/Publications/2010/09/17095123/0
[6] http://www.scotland.gov.uk/Publications/2011/03/16182005/0
[7] http://www.carbontrust.com/media/77264/ctc799_uk_tidal_current_resource_and_economics.pdf
[8] http://www.carbontrust.com/media/202649/ctc816-uk-wave-energy-resource.pdf

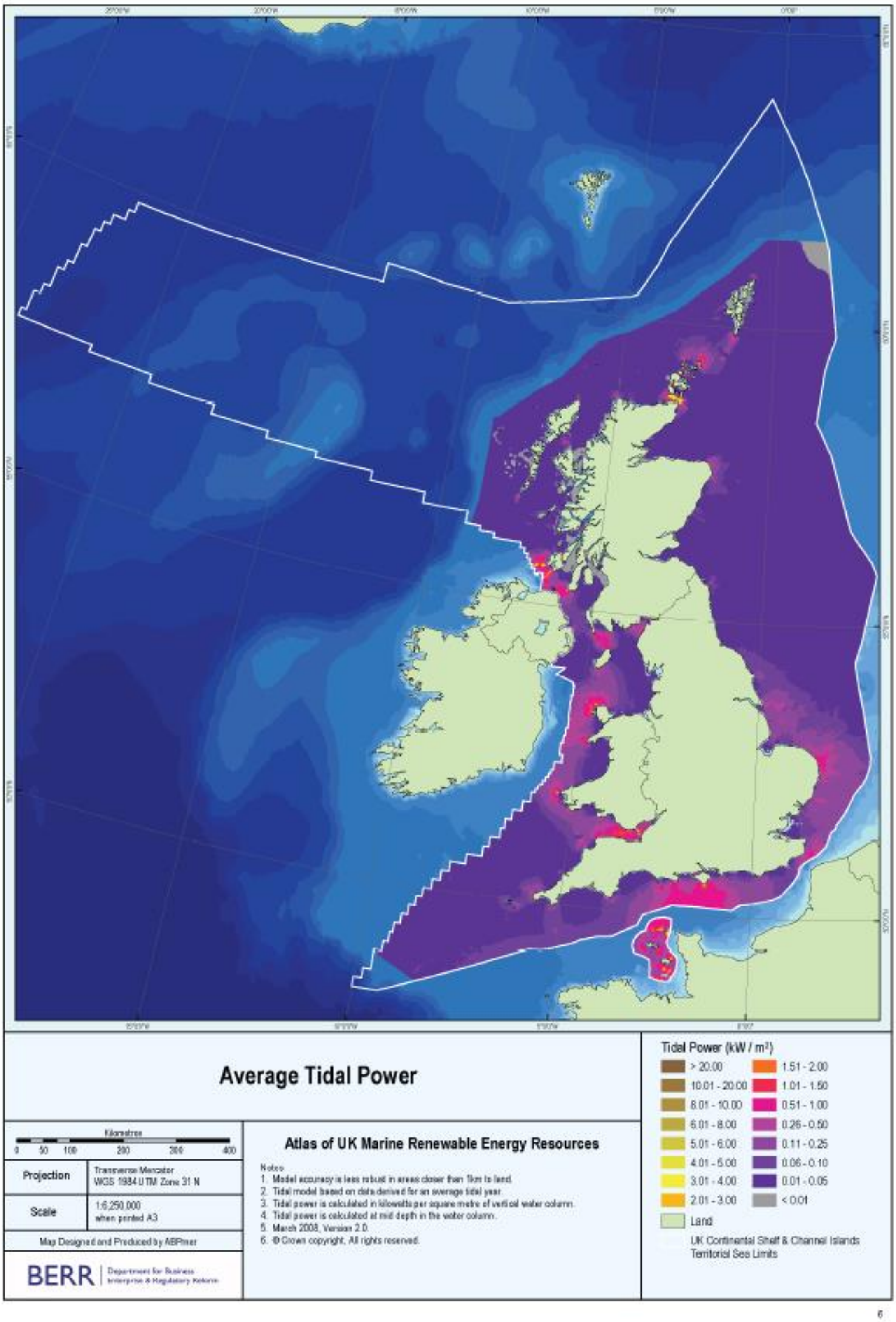

Figure 16: Average tidal power (BERR, 2008)[9]

[9] Reproduced from http://www.renewables-atlas.info/ © Crown Copyright

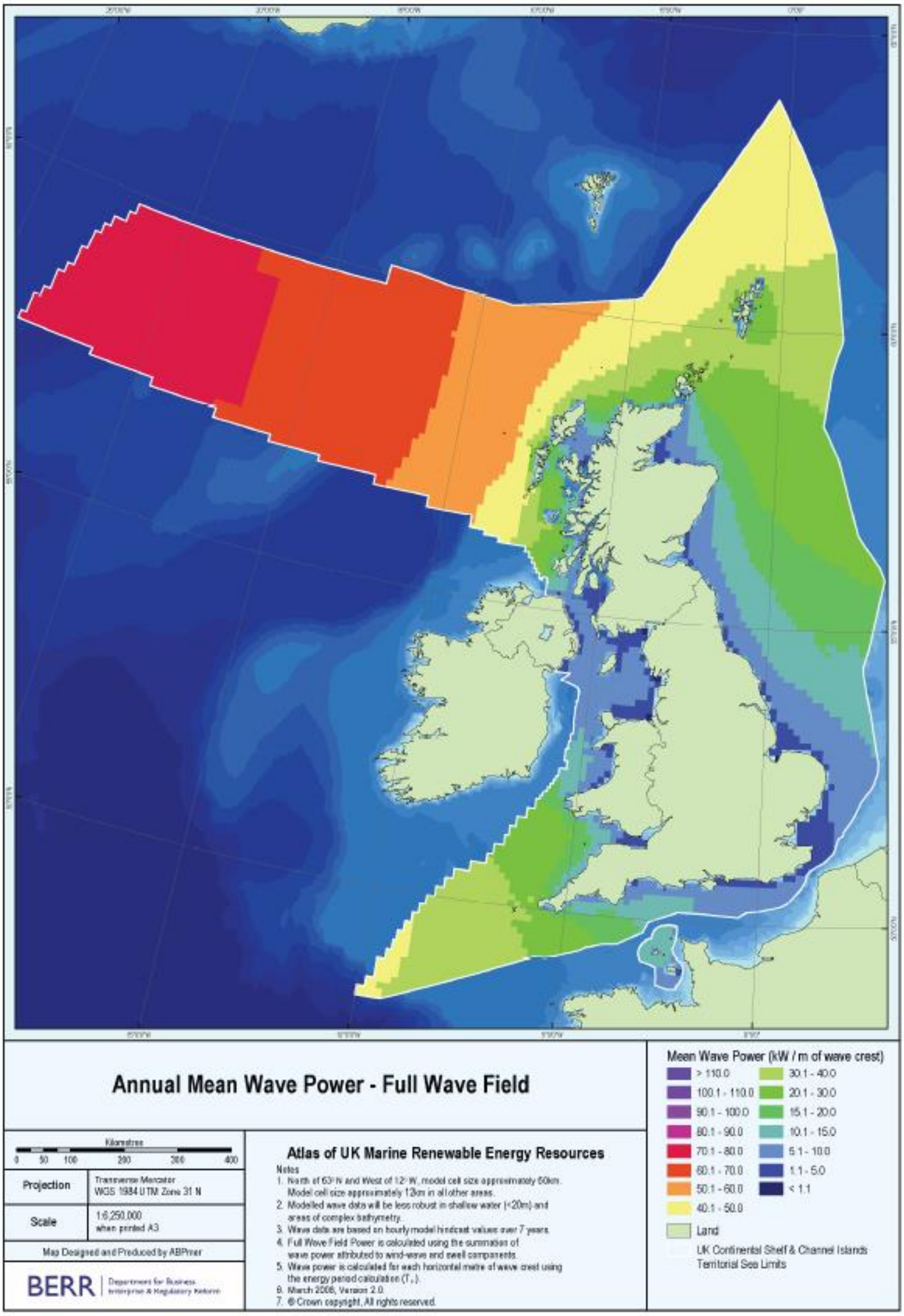

Figure 17: Average mean wave power (BERR, 2008)[10]

[10] Reproduced from http://www.renewables-atlas.info/ © Crown Copyright

5.2.3 Water Depth and Seabed Conditions

The depth of water and seabed conditions at the potential site will have direct implications for the type and size of device that can be deployed at the site. Seabed mounted, floating and surface piercing tidal devices have different requirements, as will offshore and near shore wave devices. Clearance may be required between the seabed and the bottom of the device, or equally between the sea surface and top of device. For more information on device specifics please refer to Section 6: Technology Categories.

Engineering considerations such as foundation or mooring types (i.e. gravity foundations, piled foundations or mooring systems) and wave loading (the forces of storm waves through the water column on the device below), should be taken into account. Other human considerations including navigation and shipping, recreational sea use and commercial fisheries should be considered in relation to water depth and seabed condition requirements.

Water depth information can be found on admiralty charts (available from the UK Hydrographic Office), although care should be taken as some charts are based on older survey methods and may not provide sufficient information through fast flowing tidal races or in nearshore locations of intensive wave activity. Other sources of information are provided below.

PUBLICALLY AVAILABLE RESOURCES FOR WATER DEPTH AND SEABED CONDITIONS

Marine Scotland Science, 2012a. National Marine Plan interactive (NMPi)[11]. The tool allows viewing of different types of information and where appropriate, links have been provided to the related parts of Scotland's Marine Atlas where the information is discussed in more detail.

Marine Scotland Science, 2012b. Marine Scotland Interactive (MSI) [12] provides access to spatial data held by Marine Scotland, including survey and monitoring work.

5.2.4 Grid

The standard approach is to connect renewable energy generation to the national grid. Projects would be connected in such a way that electricity generated by the wave or tidal turbines is allowed on to the national grid in a controlled manner. Permission to connect to the grid is a highly regulated process and need to ensure due process, time and funds in place. It may be possible to look at options for supplying local energy requirements as well but it would need development work as it is not the norm. At an early stage there is a need to assess options and apply for grid connection through the organisations who manage the grid. The first key contacts in Scotland are two Distribution Network Operators (DNO): SP Energy Networks and Scottish and Southern Energy (SSE). SSE operate areas of Scotland to the north of Glasgow and Perth, with SP Energy Networks operating the south of Scotland.

Typically large projects (above approx 40MW) will be connected to the transmission network (at 132kV or higher) and smaller projects to the distribution network (typically at 33kV or lower). Small scale projects (i.e. <1MW) may be able to connect to a small local private network. As a general rule, projects of more than 8MW capacity would require connection into at least the 33kV network.

The Scottish grid infrastructure is at full capacity in many places and connections for new generation can have a long lead time to become operational. The availability of a grid connection for a community project may have significant implications on aspiration timescales.

There are a number of routes than can be followed in assessing a suitable grid connection:

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[11] http://www.scotland.gov.uk/Topics/marine/seamanagement/nmpihome
[12] http://www.scotland.gov.uk/Topics/marine/science/MSInteractive

* Grid feasibility study undertaken by specialist electrical consultancy – this can take typically 3-8 weeks to complete. It is based on consultancy knowledge and publicly available information.
* Grid feasibility study undertaken by DNO – this can take 2-3 months to complete. It is based on DNO network knowledge and publically available information.
* Grid application to DNO – this can take up to 3 months to receive a connection offer based on the most economical connection option.

Only a grid application reserves a place in the queue for connecting to the grid. In other words if a study is undertaken that identifies capacity, when an application is submitted the capacity identified may have been allocated to another project.

Once a connection offer is made there will typically be three months to accept the offer. Accepting the offer involves paying part or all of the estimated connection costs. The amount to be paid can vary with the estimated time to complete the grid works and the overall cost of connection. Connection with a higher cost (typically above £250k) and connection dates more than 12 months in advance usually allow for stage payments to be made, this should be discussed with the DNO when an offer has been received.

Connection costs and timescales vary with factors such as:

* Size of proposed development;
* Connection voltage of the development;
* Distance between development and connection point.

PUBLICALLY AVAILABLE RESOURCES FOR GRID

Community Energy Scotland Ltd. 2011. 'Community Renewable Energy Toolkit' provides general advice on community renewables including grid options.

Energy Network Association website[13] has a link to a 'decision tree'[14] which can help identify which application route should be followed.

5.2.5 Ecological Designations

A large portion of Scotland is important for natural heritage and wildlife conservation. There are many sites and habitats/species designated at either a local, national or international level for a variety of ecological interests. Renewable energy projects will, in general, be supported by the planning authorities while ensuring potential ecological effects have been considered during all stages of the development.

The interaction of a designated site and a potential wave or tidal scheme will depend on a number of factors. These include:

* the distance between the designated area and proposed site,
* the qualifying features (i.e. the species and/or habitats for which the area is protected) and conservation objectives (i.e. long terms aims for the species and/or habitats); and
* the type and scale of device.

[13] http://www.energynetworks.org/electricity/engineering/distributed-generation/distributed-generation.html

[14] http://www.energynetworks.org/modx/assets/files/electricity/engineering/distributed%20generation/Jan%202013/Way%20in%20-%20decision%20tree%20-%20Jan2013.pdf

Location of a proposed site close to, or in, a designated area will likely result in increased timescales and costs associated with ecological survey works and assessment. It may also increase the risk of not successfully gaining planning consent for a development.

As well as interaction with offshore designations, onshore designations should also be considered, as these may impact on the location and survey requirements of onshore infrastructure (such as areas of protected habitat, breeding bird areas, protected mammals). The main considerations pertinent to Scotland are detailed below.

Key organisations to engage with at an early stage include SNH, RSPB, local nature interest groups who may have relevant data sets for future stages of the development.

Designations of International Importance

- Special Areas of Conservation (SAC) – classified for habitats or species other than birds.
- Special Protection Areas (SPA) – notified for important populations of birds

The above are part of the Natura 2000 network of sites which is a European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals. They are designated under European legislation, the Habitats and Birds Directives. For further information please refer to the data sources listed below.

- Ramsar Sites: Designated under the Convention on Wetlands of International Importance, and are intended to protect waterfowl habitat and wetland conservation.

Considerations of National Importance

- Marine Protected Areas (MPA) – under consideration by the Scottish Government
- National Nature Reserves (NNR) – for the conservation of habitats and species of national and international significance
- Sites of Special Scientific Interest (SSSI) (UK) – national network of areas considered to best represent natural heritage, designated under UK and Scottish law.
- UK Biodiversity Action Plan (UKBAP)
- Priority Marine Features (PMFs) – habitats and species considered to be marine nature conservation priorities in Scottish Waters.

Consideration should also be given to sites of local nature conservation interest, usually available through the local authority development plan, and Local Biodiversity Action Plan habitats and species (LBAP). These local designations may influence onshore grid connection and infrastructure requirements.

5.2.6 SACs and SPAs

Associated with each designated site will be a list of qualifying features (i.e. the species and/or habitats for which the area is protected) and conservation objectives (i.e. long terms aims for the species and/or habitats).

The Conservation of Natural Habitats and Wild Flora and Fauna 1992 (Habitats Directive) affords protection to these sites with the aim of maintaining or restoring natural habitats and wild species (as listed on Annexes) to a Favourable Conservation Status (FCS). The Habitats Directive has been transposed into Scottish law in territorial waters (within 12 nm) with the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) (known as the Habitat Regulations) and in offshore waters (out with 12nm) via the Offshore Marine Conservation (Natural Habitats, &c.)Regulations 2007.

5.2.7 Species Protection

The above Directive also provides strict protection to species listed on Annex IV of the Directive with all of these species whose natural range includes UK waters being known as European Protected Species (EPS). The full list of EPS occurring in the UK can be found on the relevant countryside agencies websites. These will require careful consideration in relation to any potential project.

The Marine (Scotland) Act 2010 replaces the Conservation of Seals Act, 1970 in Scottish waters. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland. Under the Act is it also an offence to harass seals at haul-out sites.

PUBLICALLY AVAILABLE RESOURCES ON ECOLOGICAL DESIGNATIONS

Scottish Executive, 2007, Strategic Environmental Assessment (SEA)[15] provides information on protected sites and species around Scotland.

Natura Sites in Scotland, SNH Booklet [16]

SNH web pages: 'Information Service' [17] ; 'International Designations' [18] ; 'National Designations' [19]

Marine Scotland Science, 2012a, 'National Marine Plan interactive (NMPi)[20]. The tool allows viewing of different types of information and where appropriate, links have been provided to the related parts of Scotland's Marine Atlas where the information is discussed in more detail.

Marine Scotland Science. 2012b , Marine Scotland Interactive (MSI) [21] provides access to spatial data held by Marine Scotland, including survey and monitoring work.

5.2.8 Human Environment

Considerations should be given to other sea and coastal users and their interaction with a potential wave or tidal scheme. Different users will have the capacity for varying levels of constraint on a potential site, for example restricting site and device type or increasing survey and assessment requirements at a later stage (be that EIA, construction or operation). Information should be gathered on the topics below and comments are provided on potential key effects to be considered.

- MOD use of the site and surrounding areas, i.e. for submarine and naval training, passage to other training areas etc. Temporary disruption is possible during construction and long term disruption (operations) possible if the site is located close to or within a practice or exercise area. In general, consultation with the MOD at an early stage is recommended to identify potential interactions.
- Shipping and navigation. Potential effects both during construction and operations include increased journey times and distances, displacement of shipping density in constrained areas, reduced access to ports and harbours, collision risk, reduced visibility and increased complexity of search and rescue operations. Effects such as collision risk will depend on the device type, depth of water and clearance distances above the devices. Early consultation with relevant

[15] http://www.scotland.gov.uk/Topics/marine/marineenergy/wave/WaveTidalSEA
[16] http://www.snh.gov.uk/docs/C248050.pdf
[17] http://www.snh.gov.uk/publications-data-and-research/snhi-information-service/
[18] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/
[19] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/
[20] http://www.scotland.gov.uk/Topics/marine/seamanagement/nmpihome
[21] http://www.scotland.gov.uk/Topics/marine/science/MSInteractive

stakeholders is recommended and a Navigation Risk Assessment is likely to be required as part of any application. Cumulative issues should also be considered.

- Recreational use of the sea and coastline (i.e. diving, walking, fishing, sailing). Potential effects during installation include disturbance from increased noise, access restrictions and increased transport vessels and vehicles. Landscape, seascape and visual amenity may be affected during operations. In general these potential effects can be mitigated by careful site selection, design, construction methodologies and local consultation.
- Commercial fisheries. Potential effects vary dependent on the type of commercial fisheries, however could include disturbance on fishing grounds (i.e. unable to safely access areas due to devices) and increased pressure on alternative fishing grounds. Effects on species include disturbance of sediments and underwater noise. Mitigation measures will depend heavily on the scale and type of local fisheries, and may include site design and construction methods.
- Infrastructure (ie gas pipelines, electricity cables etc). Location of devices on or close to known pipelines and cables should be avoided during the design stage. Potential effects may be direct damage caused by physical interaction or reduced access to existing infrastructure for maintenance and repair activities.
- Marine and coastal archaeology, including ship wrecks. Known archaeological features should be avoided during the design stage. Consideration should be given to construction methods such as piling, dredging, placing structures on the seabed and cabling laying operations such as trenching. Grid connection routes should consider coastal and onshore cultural heritage (e.g. listed buildings, scheduled ancient monuments etc), with regard to both direct disturbance and effects on the setting of historic features.
- Dredging and dumping areas. These areas have potential to include contaminated sediments and disturbance should be avoided. Other potential affects include disruption to vessels transiting to these areas (journey lengths and times).
- Landscape, seascape and visual considerations. Note should be taken of any national or local designations (National Parks, Areas of Outstanding Natural Beauty etc) and proximity to the proposed site. Potential effects can include visual impacts from key views (vantage points, tourist attractions, roads and footpaths) and effects on the context and characteristics of the land or seascape. These effects can be mitigated by device choice and careful site and infrastructure design.

PUBLICALLY AVAILABLE RESOURCES ON HUMAN ENVIORNMENT

Admiralty charts (available from the UK Hydrographic Office).

Marine Coastguard Agency (MCA) Marine Guidance Note "Offshore Renewable Energy Installations - Guidance on UK Navigational Practice, Safety and Emergency Response Issues" [22]

Marine Scotland Science, 2010, Regional Locational Guidance, in support of the Saltire Prize Programme, details areas of Scotland's seas considered most appropriate for development of wave and tidal energy and constraints to be considered.

Marine Scotland Science. 2012a. National Marine Plan interactive (NMPi)[23]. The tool allows viewing of different types of information and where appropriate, links have been provided to the related parts of Scotland's Marine Atlas where the information is discussed in more detail.

Marine Scotland Science. 2012b. Marine Scotland Interactive (MSI)[24] provides access to spatial data held by Marine Scotland, including survey and monitoring work.

[22] http://www.dft.gov.uk/mca/mcga-mnotice.htm?textobjid=0BD60265A97A9E76
[23] http://www.scotland.gov.uk/Topics/marine/seamanagement/nmpihome

Maritime Data[25], is an online GIS System which displays and allows download of maritime data for the entire UKCS hosted by DECC. The site is intended to provide a portal for interested parties to obtain an understanding of the maritime environment around the UK.

Ordnance Survey maps.

PASTMAP[26], a map-enabled query system for Scottish national and regional archaeological and architectural datasets.

Scottish Executive, 2007, Strategic Environmental Assessment (SEA)[27] provides information on protected sites and species around Scotland.

Scottish Government, 2011a, Scotland's Marine Atlas: Information for the National Marine Plan [28] is an assessment of the condition of Scotland's seas, based on scientific evidence from data and analysis and supported by expert judgement and contains a wealth of information on Scotland's seas.

5.2.9 Supply Chain, Ports & Harbours and Socioeconomics

An important benefit for any coastal community wave or tidal development, is the associated socioeconomic benefits, and opportunities for the local industry to be involved in any development. Consideration should be made of the local infrastructure facilities, including port facilities and supply chain at an early stage. A central difference between community energy projects and conventional commercial developments is the opportunity to secure socio-economic benefits for the local community, and this factor may influence the aims and vision of any community development.

At feasibility stage, consideration should be given to existing ports, vessels and infrastructure available locally and any existing plans or investment for the facilities. Local companies with opportunities to support site surveys and investigations as well as construction or long term operation and maintenance supply chain should be considered in detail.

For further discussion please refer to Section 7: Supply Chain, Vessel and Port Considerations and Section 8: Socioeconomic Considerations.

5.3 Further Technical Assessments

Following initial feasibility assessment it is recommended that the resource available at the potential site is examined in greater detail than that available in public documents. As level of energy available is critical to the success of the project this should be prioritised before any other large levels of expenditure.

5.3.1 In Water Measurements

Direct measurement of the wave/tidal resource is generally carried out through the deployment of measurement equipment over a period one month (tide) to one year (wave). With tidal projects capturing one month of data allows for further analysis to generate a good representation of the expected available energy on site. The one year record for wave projects allows for seasonal variation to be estimated. Measurements will require the use of a small work boats to deploy and retrieve the equipment. As an alternative for tidal energy projects a 24-48hr deployment may be

[24] http://www.scotland.gov.uk/Topics/marine/science/MSInteractive
[25] www.maritimedata.co.uk
[26] http://jura.rcahms.gov.uk/PASTMAP/start.jsp
[27] http://www.scotland.gov.uk/Topics/marine/marineenergy/wave/WaveTidalSEA
[28] http://www.scotland.gov.uk/Topics/marine/science/atlas

considered; however as much of the costs is in the hire of vessels and personnel it may be only marginally cheaper. Due to the extent of monitoring required for wave energy projects it may be more cost effective to consider numerical modelling, Section 5.3.2, of the site prior to in-water measurement.

5.3.2 Numerical Modelling

Many of the publically available resource documents are based on the numerical modelling of wave and tidal conditions rather than real-world measurements. While measuring wave and tidal energy gives an accurate representation of the site; for examination of large areas, particularly when searching for a development site, numerical models must be used to give spatial coverage.

In the case of tidal energy the velocity of the tidal race can change rapidly between different areas of a sound or channel. The numerical model can be checked against the modelled data to ensure its accuracy then used to estimate the energy at other locations; which can then be ground truthed with further measurements. In the case of < 1MW consisting of five to six smaller devices numerical modelling may not be necessary.

As noted in Section 5.3.1 above, numerical modelling for wave energy projects may be a more cost effective approach to direct measurement if the area to be considered is large or the bathymetry changes rapidly in waters of less than 20m. As with tidal energy models the measured wave data is used to check the accuracy of the numerical model.

5.3.3 Initial Engineering Study

Having reached satisfaction that an exploitable resource exists on site it is recommended that initial engineering studies, Front End Engineering Design (FEED) Study be carried out. This is a high level design study that takes a selection of, possibly generic, device designs and determines the mechanical loads that they will be placed under and uses this to create a design envelope into which a potential device design will need to fit. This can be used to narrow technology designs when submitted to manufacturers and to inform the parameters of any subsequent environmental surveying and assessment.

5.3.4 Bathymetry Surveys

Depending on the location of the potential project bathymetry data may already exist in a useable format. However, as tidal races and high energy wave sites are difficult to survey bathymetry data as used to create UKHO navigation charts may be old and/or incomplete. For large areas bathymetry surveys may be expensive to carry out and the area to survey should be restricted to as small an area as practically possible. An alternative at an early project stage may be to ask local fishermen and leisure sailors if they record depths from on-board equipment. While not as accurate as professional survey data it may allow for the relative accuracy of charted data to be tested.

5.3.5 Geophysical and Geotechnical surveys

The level of geophysical and geotechnical surveying (investigation of the seabed and rock structure) will be determined by the type of technology to be installed; and in some cases may determine which technology can be installed. Each device foundation will have its own requirements that will need investigation of the seabed and may require the drilling of boreholes to test rock strength for the fixing of bolts or piles. It is also sometimes possible to gather an indication of seabed characteristics from benthic surveys carried out for ecological purposes.

5.4 Consenting, Licensing and Lease Arrangements

This section intends to inform community groups of the policies, processes and key consultees that require consideration, in order to achieve the necessary permissions. As detailed below, there a several public documents and guides providing advice and information on each process.

5.4.1 Required Permissions and/or Licences

A wave or tidal deployment will require one, more or all of the following permission/licences:

- Marine Licence (regulator is Marine Scotland through the Marine Licensing and Operations Team. Jurisdiction extends up to mean high water springs (MHWS);
- Agreement for Lease to use the seabed (granted by The Crown Estate). Jurisdiction extends up to mean high water springs.
- Section 36 consent (required if over 1MW total generating capacity) under Section 36 of the Electricity Act 1989 (regulator is the Scottish Ministers);
- Town and Country planning permission (regulator is the Local Planning Authority) for onshore elements. Jurisdiction extends down to mean low water springs (MLWS).
- European Protected Species licence to disturb (competent authority will be the appropriate regulatory authority, i.e. Marine Scotland or Local Planning Authority).
- If activities are proposed within a local harbour authority a Works Licence may be required (the competent authority will be the Local Harbour or Port Authority).

5.4.2 Policy Framework

Coastal and marine developments are licensable activities which are administered by Marine Scotland on behalf of the Scottish Government, under the provisions of the Marine (Scotland) Act 2010. Along with this Act, the UK Marine and Coastal Access Act 2009 provides a framework for marine management. Marine Scotland's Licensing Operations Team (MSLOT) issue licenses on behalf of the Scottish Ministers.

Marine planning documents include:

- UK Marine Policy Statement: created and adopted by the UK and devolved administrations to facilitate integrated approach to marine planning.
- Scottish National Marine Plan: Scottish Ministers' policies for the sustainable development of Scotland's seas and guides regional planning once Scottish Marine Regions have been established.
- Scottish Regional Marine Plans: inform marine licensing and other decision making functions. These are produced on a regional basis across 11 marine regions as shown in Figure 18.
- Strategic Environmental Assessment (SEA) for Marine Renewables (Scottish Executive, 2007) examines the environmental effects of developing wave and tidal power and informs the Scottish Government's strategy for wave and tidal energy development.

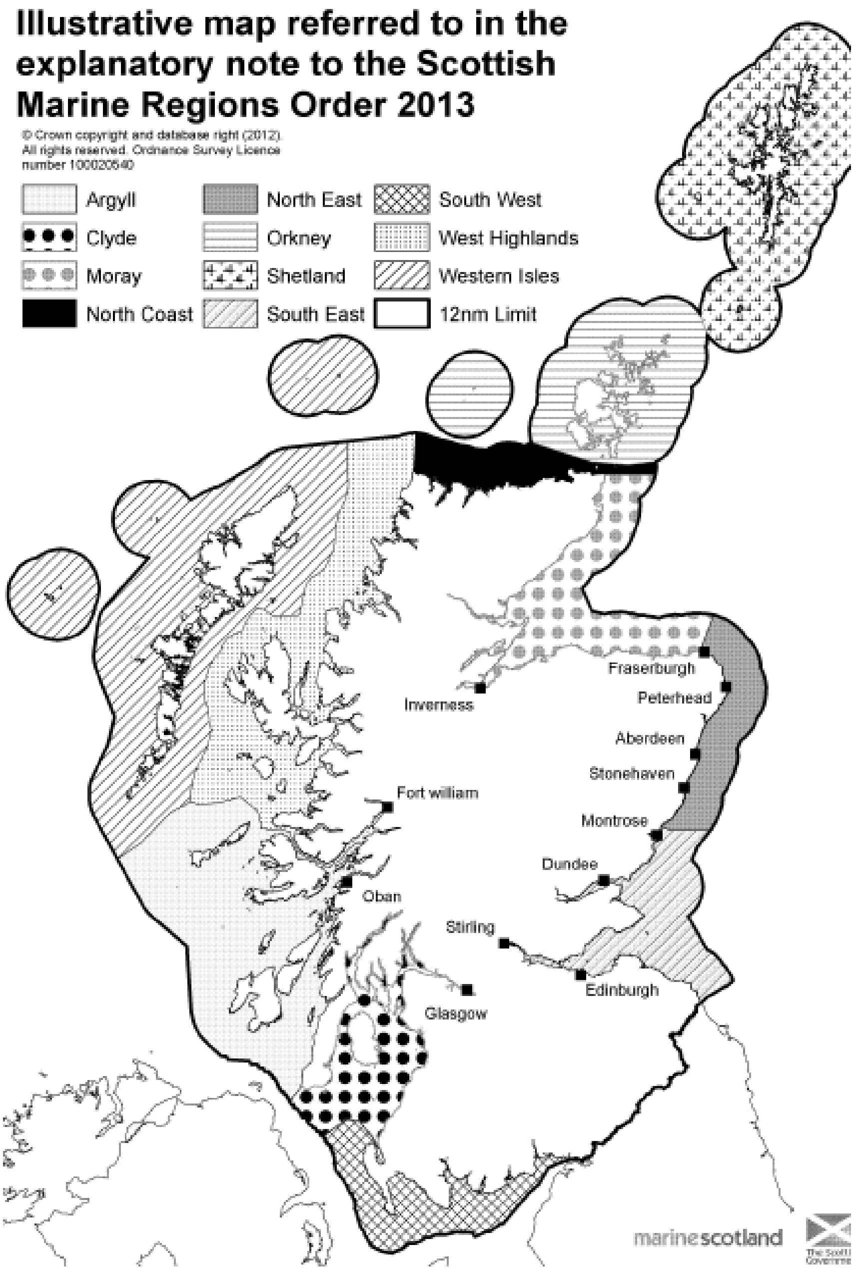

Figure 18: Boundaries of Scottish marine regions (Marine Scotland, 2012)

Projects will require both a Marine Licence to consent the offshore activities up to mean high water springs (MHWS) and planning permission under the Town and Country Planning (Scotland) Act, 1997, for the onshore works down to mean low water springs (MLWS).

A wave or tidal generating station of over 1MW will require consent under Section 36 (s36) of the Electricity Act 1989.

The EU Council Directive 85/337/EEC requires an Environmental Impact Assessment (EIA) to be carried out for certain plans or projects, a requirement which has been transposed into Scottish law by Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000. Under these regulations Scottish Ministers are required to consider whether any proposal for an offshore renewable energy device is likely to have a significant effect on the environment. The regulations were amended in 2008 by the Electricity Works (Environmental Impact Assessment) (Scotland)

Amendment Regulations 2008 to meet the requirements of the Public Participation Directive, 2003/35/EC.

5.4.3 Licensing and EIA process

A number of guides are available publically, explaining in detail the marine licensing process (including a number of flow diagrams) and these are listed at the end of this section. Rather than repeat the information in these documents, Table 3 provides a high level summary of the process and indicative timescales.

Table 3: Overview of consenting and licensing process

Stage in process	Step	Details	Timescales
1	Pre-application requirements	Inform Marine Scotland Licensing and Operations Team (MSLOT), in writing, with as many details of the project/proposal as possible. MSLOT may require a pre-meeting and will offer expert advice about the process. Early contact with MSLOT is advised.	MSLOT seek to provide a reply within **28 business days** after receipt of a written request for advice or a written submission.
2	Pre-screening meeting (if required)	Before attending a meeting with MSLOT you should supply as many details of the proposed development as possible, eg: • Device design and operation envelope (final choice of device is not necessary); • Mooring method or options; • Area(s) under consideration; • Location/constraints maps, charts etc; • Proposed timescales for development; • Summary of any discussions to date with stakeholders including local and national.	
3	EIA Screening	This is the process to determine if an Environmental Impact Assessment (EIA) is required for the project. A request for screening should be made in writing and accompanied by specific details of the proposal. Further details are in 'A Guide to Marine Licensing' (Scottish Government, 2012b). Projects under Schedule 1 of the *Electricity Works (Environmental Impact Assessment) (Scotland) Regulations* 2000 (as amended) are subject to EIA; projects under Schedule 2 are subject to an EIA if they are likely to have significant effects on the environment. Generally, generating stations >1MW will require an EIA; requirements for projects of <1MW will depend on site specific circumstances and will be screened on a case by case basis.	MSLOT will consult with relevant stakeholders, allowing 28 days for responses. Following this, the applicant will be informed of the Screening Opinion. In general, a screening opinion will be given within **three weeks**.

Stage in process	Step	Details	Timescales
4	Scoping of EIA	The process of agreeing the scope of the EIA. The applicant should request a scoping opinion, usually accompanied by a Scoping Report, outlining specific details of the proposal, proposed survey and assessment methodologies.	Assuming consultation responses are received by MSLOT within expected timescales, a scoping opinion would be given within **nine weeks**.
5	Gathering information to inform an EIA.	Following best practice and scoping responses from key stakeholders, applicant conducts desk based reviews and on site surveys. This may include ecological surveys both on and offshore, shipping and navigation studies, socioeconomic data collection etc.	Applicants may need to carry out environmental surveys for at least **one year**, and may require **two** depending on the level of environmental concern associated with elements of the project and potential environmental interactions.
6	Pre-application Consultation	Applicants are required to place a pre-application notice, hold a public consultation event and produce a pre-application report.	Consult competent authority (Marine Scotland or LPA) for detailed guidance for timescales, but consultation should occur early in the process.
7	Carrying out of EIA and compilation of ES or provision of a report with supporting environmental information if no EIA is required.	The ES or supporting environmental information report should cover all information specified in the scoping opinion and be a transparent and independent assessment of the potential environmental effects of the proposal. If an EIA is required, specific topics and assessment are required.	Depends on complexity of the development. Assuming all data is gathered and processed, the assessments and compilation would take between **two and six months**.
8	MSLOT gate checking of documentation	Section 36 applications will be checked at a high level by MSLOT to ensure all requirements of the scoping opinion and EIA requirements have been included.	**A minimum of three weeks.**
9	Submission of application for development	The ES will be taken into account by the consenting authority in reaching a decision on consent. A fee is required to be paid. The ES will be made public.	n/a
10	Consultation with stakeholders and statutory advisers	Specific requirements for advertising of applications in the press etc may be required. The competent authority (Marine Scotland or local planning authority) will lead the consultation process for the development.	Timescales may vary for placement of adverts. Consult with competent authority (Marine Scotland, local planning authority etc) for specific requirements.
11	Determination: licence refused or granted.	MSLOT issue consents/licenses on behalf of the Scottish Minsters. For separate Town and Country planning applications, the local planning authority will issue consent. It is usual for a license/consent to be issued with conditions attached.	Aspiration timescale of **nine months** for Section 36 applications, depending on complexity of application. Simple applications can be dealt with in between eight to 12 weeks.

5.4.4 General EIA comments

The EIA process can be lengthy, involved process, usually requiring specialist input. The EIA, documented through the Environmental Statement, should demonstrate that all potential significant impacts arising from the interaction of the proposal and the baseline environment have been assessed. It should detail baseline information, project description, survey and assessment methodologies, data gaps, mitigation measures and identify residual impacts. It should consider the development as a whole including offshore and onshore elements, as requested by regulators.

A number of wave and tidal developers have submitted applications to Marine Scotland and the accompanying ES's can be found on the Marine Scotland website.

In general an EIA is expected to consider the following topics:

- Offshore Physical Environment
  - Bathymetry and Geology
  - Marine and Coastal Processes
- Onshore Physical Environment
  - Geology
  - Hydrology and Hydrogeology
- Offshore Biological Environment
  - Benthic and Intertidal Ecology
  - Fish and Shellfish
  - Ornithology
  - Marine Mammals
  - Underwater Noise
- Onshore Biological Environment
  - Terrestrial Habitats, Ecology and Ornithology
- Offshore Human Environment
  - Commercial Fisheries
  - Shipping and Navigation
  - Marine Archaeology and Cultural Heritage
  - Existing Infrastructure and Military considerations
  - Socioeconomics
- Onshore Human Environment
  - Archaeology and Cultural Heritage
  - Existing Infrastructure, Aviation and Military considerations
  - Socio-economics, Recreation and Land Use
  - Noise and Vibration
  - Landscape, Seascape and Visual Resources
  - Ports and Harbours, Traffic and Transport
  - Air Quality and Carbon Balance
- Cumulative and In Combination Effects

The specific baseline data, survey methodologies and assessment methodologies will be determined through the EIA Scoping process and consultation. For some wave and tidal proposals, some of the above topics may be dealt with in a less rigorous manner, depending on the sensitivity of the site, cumulative effects and the proposed development.

Within the EIA process, it is often the offshore ecology survey works that form the critical path. In general, one year of offshore ecology survey work will be required, however potentially stakeholders could request two years of survey data to inform the EIA depending on the sensitivity of the interest and the potential interactions with the project. Marine Scotland have produced 'Survey, Deploy and

Monitor Licensing Policy Guidance' (Scottish Government, 2012a) to provide an efficient risk-based approach for taking forward wave and tidal energy proposals. This should be referred to from the outset. It should also be noted that some survey works have specific times of year which they are ideally carried out in, e.g. migratory birds or onshore breeding bird surveys.

Marine Scotland and other stakeholders have access to a wealth of marine datasets, including various survey programmes being run by Marine Scotland, and should be approached at scoping stage for access to the data sets.

All survey works should be carefully planned and agreed with relevant consultees prior to initiation. The level, timescales and costs of survey requirements should be accounted for in any project proposal.

5.4.5 Habitats Regulations

In addition to the EIA process outlined in the section above, wave and tidal projects may require consideration under the Conservation of Natural Habitats and Wild Flora and Fauna 1992 (Habitats Directive). The aim of this Directive is to maintain or restore natural habitats and wild species (as listed on Annexes) to a Favourable Conservation Status (FCS). The Directive introduced a range of measures including the development of a network of protected sites (Special Areas of Conservation: SACs) for listed habitats (Annex I) and species (Annex II). In addition, strict protection is afforded to species listed on Annex IV of the Directive with all of these species whose natural range includes UK waters being known as European Protected Species (EPS). All cetacean species are listed on Annex IV of the Habitats Directive, are classed as European Protected Species (EPS).

The Habitats Directive has been transposed into Scottish law (within 12 nm) by the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) and in offshore waters (out with 12 nm) via the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007.

In addition, the Marine (Scotland) Act 2010 replaces the Conservation of Seals Act, 1970 in Scottish waters. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland. Under the Act is it also an offence to harass seals at haul-out sites. A separate consultation is presently underway to identify haul-out sites that are to be given protection under the Act.

It may be necessary to undertake a Habitats Regulations Appraisal (HRA) should there be connectivity between habitats or species linked to either an SPA or SAC, and the proposed development.

5.4.6 Role of Marine Scotland

Marine Scotland is made up of a number of teams and it is important to understand the roles and distinctions between them. A summary is provided below and further information can be found on the Marine Scotland website.

- Marine Scotland is the directorate of the Scottish Government with responsibility for marine and fisheries issues in Scotland.
- Marine Scotland Planning and Policy Team (MSPP) provides the Marine Scotland Licensing and Operations Team (MSLOT), with independent policy advice and produces policy guidance.
- Marine Scotland Licensing and Operations Team (MSLOT) is the department responsible for assessment of application, compliance with legislation and issuing of all marine related permissions. MSLOT operates a 'one stop shop' and should be the first point of contact for all queries relating to deployment of wave and tidal devices.
- Marine Scotland Science supports MSLOT on technical and science issues.

5.4.7 Statutory Consultees and Key Organisations

A number of statutory consultees are identified under the Marine Licensing (Consultees) (Scotland) Order 2011 and The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended). Statutory consultees should be consulted with at an early stage of the EIA process, and include:

- Scottish Natural Heritage (SNH) as independent statutory advisors to Scottish Government on nature conservation out to the 12nm limit. They must be consulted in relation to a marine licence and s36 application.
- Northern Lighthouse Board (NLB) is responsible for advising on all buoys, lights and other marking requirements. They must be consulted in relation to a marine licence.
- Maritime and Coastguard Agency (MCA) ensures navigational safety of the marine environment. They must be consulted in relation to a marine licence.
- Scottish Environment Protection Agency (SEPA) role is to protect and regulate the environment including pollution prevention, coastal processes and flooding. They must be consulted in relation to a marine licence and s36 application.
- Marine Planning Partnerships have been created under the Marine (Scotland) Act, although they are still in development. They will be responsible for marine planning and integrated coastal zone management for each Scottish Marine Region (ie local marine plans and management of marine issues) and will be comprised of a number of stakeholders and representatives of Scottish Ministers.
- Local Planning Authorities (LPA) are statutory consultees for s36 applications and have responsibilities for on-land development as part of a wave or tidal deployment (i.e. grid connection infrastructure) as well as potential impacts on onshore elements (landscape and visual, recreational use etc).

Other key organisations include:

- Ministry of Defence (MOD) use Scotland's seas for training purposes and are a key organisation to consult at an early stage.
- Historic Scotland is an executive agency of the Scottish Government and charged with safeguarding the nation's historic environment. They will provide information, data and advice on cultural heritage interests.
- Health & Safety Executive (HSE) is an independent regulator for work related health, safety and illness are will provide comment on any wave or tidal application.
- Joint Nature Conservation Committee (JNCC) is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation. It has responsibility for the provision of nature conservation advice in the offshore area beyond 12 nm from the coastline to the extent of the United Kingdom Continental Shelf (UKCS). It is a statutory consultee for s36 consent and Marine Scotland is likely to consult JNCC for marine licence applications beyond 12nm.
- RPSB is a UK charity for ornithology and owns a number of wildlife reserves in Scotland. A key consultee and source of data for any wave and tidal development.
- Scottish Fishermen's Federation aims to preserve and promotes the collective interests of Scotland's fishermen's associations. They play a key role in management of the marine environment and marine spatial planning.
- Local commercial fishery groups are a key consultee group and source of local knowledge.
- Local communities are obviously an essential consultation group for any community development. Community Energy Scotland provide excellent advice on strengthen communities through renewable energy projects (Community Energy Scotland Ltd, March 2011).

- Other local sea users and interest groups, including ferry operators, recreational sailing, diving and fishing companies.

5.4.8 Crown Estate Lease Arrangements

The Crown Estate manages the seabed out to the 12nm limit and any wave or tidal development will require a lease from The Crown Estate in addition to any marine licences. The leasing process comprises at least two stages. The principle agreements comprise an Agreement for Lease (AfL), which provides a conditional right for the developer to request a Lease. In some cases The Crown Estate includes a further initial stage - an exclusivity agreement.

A number of different frameworks have been used for applications for leases, however all follow similar stages of expressions of interest, pre-qualification, tendering, interviews, negotiation and award.

FURTHER RESOURCES FOR THE CROWN ESTATE LEASE PROCESS

'The Crown Estate Role in Offshore Renewable Energy Developments: Briefing' [29]. The paper outlines the basis of the leasing process.

The Crown Estate 'Wave and Tidal' web pages [30]. The Crown Estate, webpages, 'Wave and Tidal' provide an overview of objectives and activities, wave and tidal portfolio, processes and publications.

5.4.9 Key Guidance Documents for Consenting and Licensing

Marine Scotland have produced a number of general guidance documents as detailed below.

FURTHER RESOURCES ON MARINE SCOTLAND CONSENTING AND LICENSING

Scottish Government, 2012b, 'A Guide to Marine Licensing (2011)' [31], updated 30 May 2012

Scottish Government. 2012c. 'Draft Marine Renewable Licensing and Consents Manual' [32]

Scottish Government, 2013, 'Good Practice Guidance'[33], Scottish Government Energy Consented and Deployment Unit, Jan 2013. This document focuses on onshore wind good practice, but contains many common themes and useful advice.

Scottish Government, Guidance on the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000[34]

Scottish Government, 2011c. 'Guidance on the Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2008'[35]

[29] http://www.thecrownestate.co.uk/media/387737/role-in-offshore-renewable-energy.pdf
[30] http://www.thecrownestate.co.uk/energy-infrastructure/wave-and-tidal/
[31] http://www.scotland.gov.uk/Topics/marine/Licensing/marine/general
[32] http://www.scotland.gov.uk/Topics/marine/Licensing/marine/LicensingManual
[33] http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Infrastructure/Energy-Consents/Guidance/goodpracticeguidance
[34] http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Infrastructure/Energy-Consents/Guidance/EIA-Guidance
[35] http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Infrastructure/Energy-Consents/Guidance/EIA-Amendment-Regs-2008

6. TECHNOLOGY CATEGORIES

6.1 Overview

In some instances, a community group may decide a 'technology neutral' approach best serves their aims and aspirations, that is, to seek consent/licence for a development that does not specify the device to be installed. It is recommended, however, that the scale and conceptual type of the preferred technology is narrowed down wherever possible, as this will facilitate discussions with stakeholders, grid operators and The Crown Estate.

While both wave and tidal technologies have made significant progress over the past decade; tidal technology at present is more amenable to a community backed project. This is principally due to the resource requirements necessary to drive a project and their geographical location with respect to exposure of sites and the engineering challenges to be faced. By their nature wave energy sites are in exposed locations and by the inherent physical processes on which power extraction is based require large structures and associated infrastructure. This lends itself to the development of large scale projects for which utility balance sheet finance will be required for the foreseeable future. This being said there may be the opportunity for near shore technologies such as Aquamarine Power's Oyster or Carnegie Wave Energy's CETO devices to be utilised in a smaller array. Reflecting this, the technology review provided below covers tidal devices only.

Further information on both tidal and wave devices can be found on EMEC webpages[36] which contains a summary of different types of devices and a list of active wave and tidal developers.

6.2 Tidal Energy Technologies

The proliferation of tidal energy technologies under development over the last ten years has led to a diffuse range of device types and company profiles; extending from start ups working with numerical models and small scale tank testing to large multinationals testing full scale equipment at facilities such as EMEC (European Marine Energy Centre) in Orkney. In selecting a technology there are certain criteria that should be followed as detailed below:

6.2.1 Technical Provenance

- **Does the technology developer have a defined concept and comprehension of how it will be followed through?** In the first instance the developer should have a clear understanding of what it is they are developing.
- **How complex is the technology?** In general the more complex a system the higher the likelihood that it will require maintenance. While advanced systems, such as satellite technologies can be designed to eliminate maintenance this comes at a cost. Technologies that utilise off the shelf components and that can be repaired easily by sufficiently qualified local technicians/engineers may be preferred over bespoke systems until such time as the volume of devices produced creates a critical mass of parts and trained engineers.
- **To what extent has the technology been tested at scale prior to the commitment for a full scale device been carried out?** In the development of tidal technologies numerical models cannot always accommodate all the physical stresses that a device would have to operate under. As such a carefully programmed series of scale tank and open water tests allows for the device concept to be subjected to real world conditions and refined at each stage. If a technology is failing to progress through these stages then its technical provenance may be questionable.

[36] http://www.emec.org.uk/marine-energy/#loaded

- **To what extent has the technology been deployed, tested and retrieved at full scale?** As with scale testing certain real world phenomenon can only be tested with a device in-situ and operating under real environmental conditions. These real world tests allow for all device components to be trialled from large structures such as the blades, support foundations and moorings down to the smallest fuse and connector. While it is possible to dry test components at specialist facilities a holistic in water test allows the device, communications system and power output to be tested as one. Where these tests have taken place they should be for an extended period of time with minimal intervention from the manufacturer and ideally will be compliant with international standards.
- **Does the technology have a means of access and maintenance that is compatible with available facilities?** As developed further in this report the means to access and service a technology is critical to its success. Without the means to quickly recover and repair a technology the device becomes reliant on fail over mechanisms whereby redundancy is built into the system to compensate for component failures. This redundancy itself adds to the complexity of the technology and therefore removes the ability for the technology to be serviced locally. An alternative to a quick recovery or redundancy is a gradual degradation in performance whereby a component failure may lead to incremental degradation of output until such time as the technology can be recovered. Where local facilities do not all for recovery to shore there may be additional downtime to be considered in transporting, repairing and repatriating the device.

6.2.2 Financial Provenance

- **What is the source of the technology developer's current investment?** In developing a technology many device manufacturers rely on a variety of investment sources. Advice should be sought from qualified personnel as to the quality and quantity of investment held by the manufacturer. Ideally a technology developer should have a stable financial backer with the assets to honour the developer's liabilities.
- **How can the device be maintained in the event of the developer discontinuing?** In its present condition the tidal industry will not be able to sustain the number of developers and devices. As the industry consolidates to a smaller number of successful designs, technologies have the risk of no longer being supported. Care must be taken in considering how these devices can be managed in the event of their supplier no longer being able to honour their warranties.

6.3 Further Information

For further information on the selection and assessment of tidal technologies the International Electrotechnical Commission (IEC) is presently preparing a suite of documents for industry covering:

- System definition
- Performance measurement of wave, tidal and water current energy converters
- Resource assessment requirements, design and survivability
- Safety requirements

These IEC documents are an evolution of industry standard documents produced by EMEC during 2010[37]. Of interest also may be the EquiMar project[38], completed in 2011, providing a suit of protocols covering tank testing, sea trials and resource assessment.

[37] http://www.emec.org.uk/standards/
[38] http://www.equimar.org/

6.4 Conceptual Tidal Energy Device Designs

To allow for an equitable comparison between potential device types for installation, for the purposes of this report, device designs have been categorised into one of five concepts below, based on an analysis of the presently available technologies and categorised to a MW or kW scale. For each category a conceptual diagram is presented, a brief description and a selection of guidance notes covering pros, cons, infrastructure requirements, socio-economic considerations and example devices.

Table 4: Categories of conceptual tidal energy designs

Rating class	Installation method	Blade diameter range
MW	Seabed mounted	12-20m
MW	Floating	12-20m
MW	Surface Piercing	12-20m
kW	Seabed mounted	2m-6m
kW	Floating	2m-6m

It is noted that these categories may not cover all device types presently under development, and alternative concepts fall out with the five categories. Please note examples of devices are provided for illustration purposes and do not necessarily represent every device in development under each category. It should also be noted that the industry is developing and the list of example devices may not provide an accurate representation of the industry in the future.

6.4.1 MW Scale - Seabed mounted device

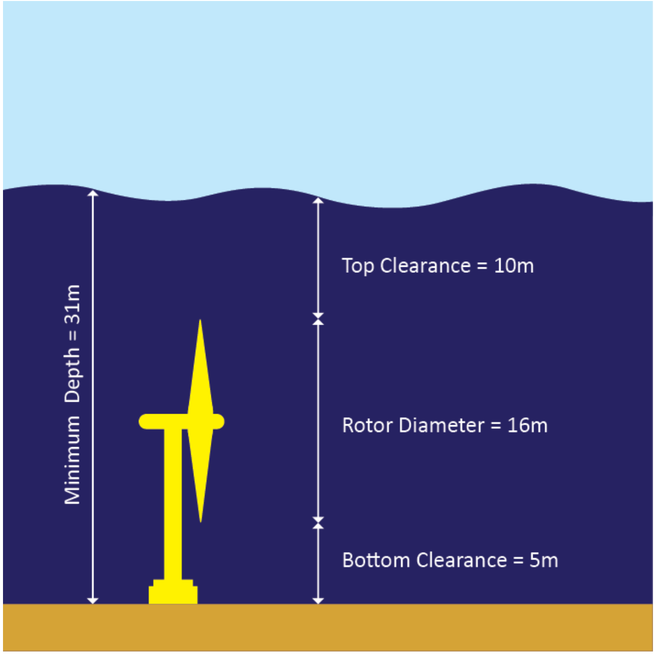

Figure 19: Example 16 m diameter seabed mounted turbine

Description:

Turbine with an equivalent rotor diameter of 12 - 20m mounted on the seabed by means of supporting structure. The equivalent rotor diameter may cover two or three bladed designs and designs encompassing a solid rotor. No distinction is drawn between supporting structures other than that they are completely submerged. This class of turbine is termed MW as developers are currently targeting devices with diameters of 16m+ in the 1MW range.

Pros:

- 10's MW scale of deployment possible
- Potential to reduce navigation concerns as situated below vessel draught
- Multinational engineering companies supporting technology development

Cons:

- Requires flows greater than 3m/s (6knots) in waters in excess of 30m depth
- Installation may require specialist equipment
- Operations and Maintenance may be expensive if recovery requires specialist equipment

Infrastructure Requirements:

- Berth water depths of > 6m for potential offshore construction/installation vessels.
- Heavy lift capacity up to 200 tonnes (including major foundation components)
- Sufficient pier loading capacity
- Quayside storage and workshops
- Longevity of port infrastructure to support O&M
- Berth exclusivity required for periods of construction/mobilisation/installation
- Exclusive quay space area required for onshore storage/working in the region of 1000 sq.m with a berthing face to handle vessels approximately up to 125m in length.

Socio-economic considerations:

- Intrusion of industrial scale construction activities within small communities
- Local community inclusion/exclusion within the required supply chain
- Conflict with other port stakeholders where infrastructure resources are limited
- Benefits of infrastructure developments to other port users and vessel operators
- Internal transport infrastructure interface

Example Devices:

Atlantis, Hammerfest, OpenHydro, Tidal Generation Limited, Kawasaki Heavy Industries, Voith Hydro

6.4.2 MW Scale - Floating device

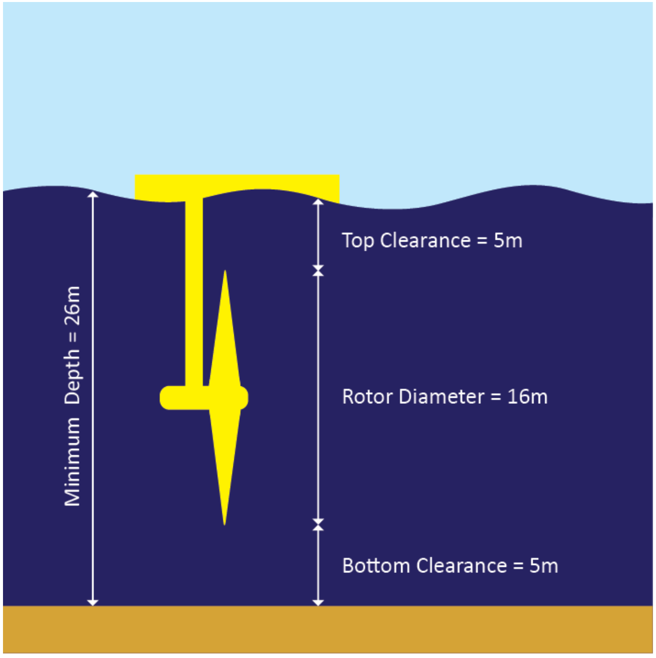

Figure 20: Example 16 m diameter floating device

Description:

Floating devices with an equivalent rotor diameter of 12 - 20m anchored to the seabed by means of a compliant mooring system. The equivalent rotor diameter may cover two or three bladed designs and vertical axis blades of an equivalent swept area. This class of turbine is termed MW as developers are currently targeting devices with diameters of 16m+ in the 1-2MW range. Devices may have larger nameplate (or rated capacity, nominal capacity, or 'maximum effort') capacity than seabed mounted devices as floating technologies commonly support two generators.

Pros:

- Increased carrying capacity with two rotors to a structure
- Access to potentially shallower sites than seabed technology
- Potentially reduced operations and maintenance costs with ability to recover and service units quickly.

Cons:

- Susceptible to extreme wave loading in exposed locations
- Mooring spreads much larger than for seabed technology
- Navigation considerations as may require a relatively large exclusion zone

Infrastructure Requirements:

- Berth water depths of > 6m for potential offshore construction/installation vessels and the wet testing/deployment of devices (Note: device may require more water depth at berth)
- Heavy lift capacity up to 100 tonnes (including major foundation/mooring components)
- Sufficient pier loading capacity
- Quayside storage and workshops
- Longevity of port infrastructure to support O&M

- Sheltered berth exclusivity required for periods of construction/mobilisation/installation and O&M with adequate alongside fendering to 'wet store' device.
- Exclusive quay space area required for onshore storage/working in the region of 1000 sq.m with a berthing face to handle vessels of approximately up to 75m in length.

Socio-economic considerations:

- Intrusion of industrial scale construction activities within small communities
- Local community inclusion/exclusion within the required supply chain
- Conflict with other port stakeholders where infrastructure resources are limited
- Benefits of infrastructure developments to other port users and vessel operators
- Internal transport infrastructure interface

Example Devices:

Bluewater Energy Services, Hydra Tidal Technology AS, ScotRenewables

6.4.3 MW Scale - Surface Piercing device

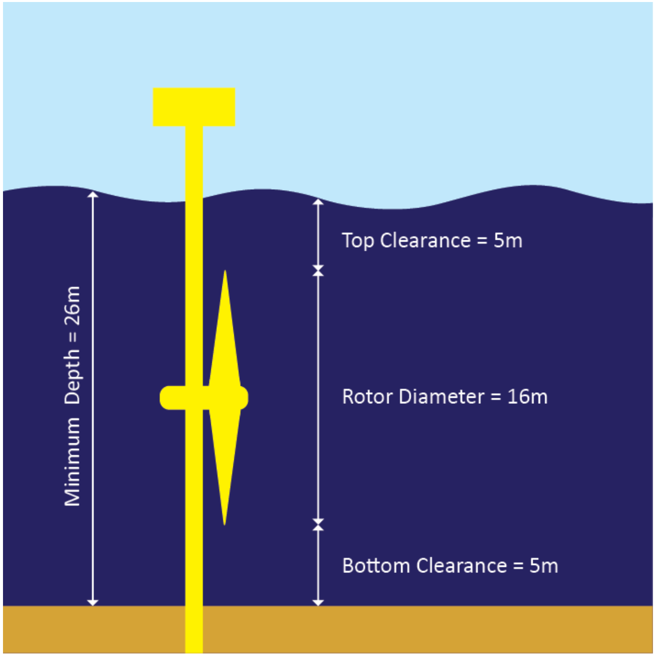

Figure 21: Example 16 m diameter turbine on surface piercing pile

Description:

Support structures for these device designs generally consist of large pile structures being drilled or piled into the seabed and protruding from the water column. Rotors or equivalent area hydrofoils are connected to the pile structure by means of a cross beam that allows for the nacelles (the housing at the centre of the rotor coving components) to be lowered and raised in the water column. As with floating technologies the structure is designed to hold two nacelles and consequently can support 16m+ (or equivalent) diameter rotors giving a nameplate capacity in the range of 1-2MW.

Pros:

- Generation and control systems held above the water line
- Nacelle's accessible and recoverable in suitable weather conditions
- Quick access for routine maintenance activities

Cons:

- Construction activities may require drill/piling operations to install
- Potential visual intrusion
- Support structured may be substantial in exposed locations with heavy wave loading

Infrastructure Requirements:

- Berth water depths of > 6m for potential offshore construction/installation vessels
- Heavy lift capacity up to 400 tonnes (including major foundation components)
- Sufficient pier loading capacity
- Quayside storage and workshops
- Longevity of port infrastructure to support O&M
- Berth exclusivity required for periods of construction/mobilisation/installation

- Exclusive quay space area required in the region of 1000 sq.m with a berthing face to handle vessels approximately up to 100m in length

Socio-economic considerations:

- Intrusion of industrial scale construction activities within small communities
- Local community inclusion/exclusion within the required supply chain
- Conflict with other port stakeholders where infrastructure resources are limited
- Benefits of infrastructure developments to other port users and vessel operators
- Internal transport infrastructure interface

Example Devices:

Marine Current Turbines, Pulse Tidal

6.4.4 kW Scale - Seabed mounted device

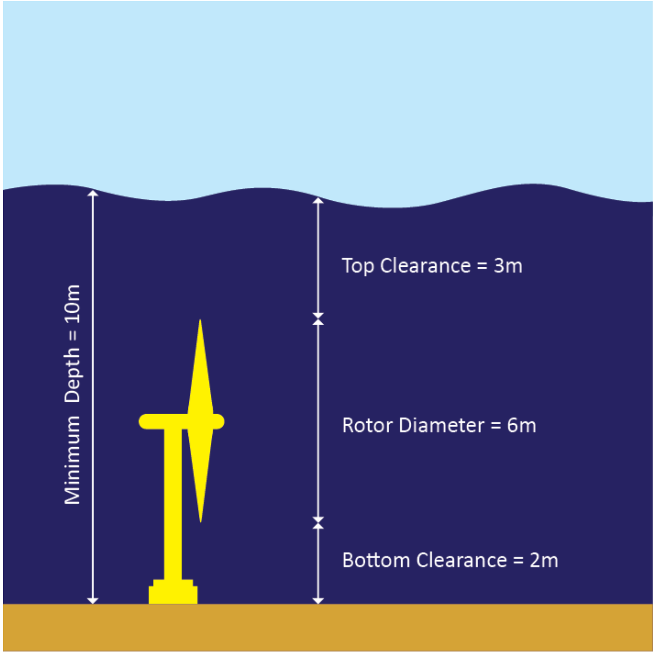

Figure 22: Example 6 m diameter seabed mounted turbine

Description:

Smaller scale turbines similar in design to a MW scale device but with a rotor diameter of 2 - 6m. The equivalent rotor diameter may be covered by two to six blades or an equivalent swept area where blade design differs. No distinction is drawn between supporting structures other than they are completed submerged and may include piles, gravity bases or clump anchors. This smaller class of turbine is termed KW as developers are currently targeting devices with diameters of 2 -6m in the 10s to 100s kW range.

Pros:

- Smaller vessel requirements for technology handling
- Commonly based on "off the shelf" components
- Targets markets are off-grid remote areas hence designed for robust handling

Cons:

- May require multiple turbines to create an economically viable project
- Installation would still require construction vessels but potentially in sheltered locations
- Servicing requires recovery of the nacelles to shore

Infrastructure Requirements:

- Berth water depths of > 5m for potential offshore construction/installation vessels
- Heavy lift capacity up to 200 tonnes (including major foundation components)
- Sufficient pier loading capacity
- Quayside storage and workshops
- Berth exclusivity required for periods of construction/mobilisation/installation
- Exclusive quay space area required in the region of 500 sq.m with a berthing face to handle vessels approximately up to 75 m in length

Socio-economic considerations:

- Intrusion of small-scale construction activities within small communities
- Local community inclusion/exclusion within the required supply chain
- Conflict with other port stakeholders where infrastructure resources are limited
- Benefits of infrastructure developments to other port users and vessel operators
- Internal transport infrastructure interface

Example Devices:

Nova Innovation, Sabella, Verdant Power, ORPC

6.4.5 kW Scale - Floating device

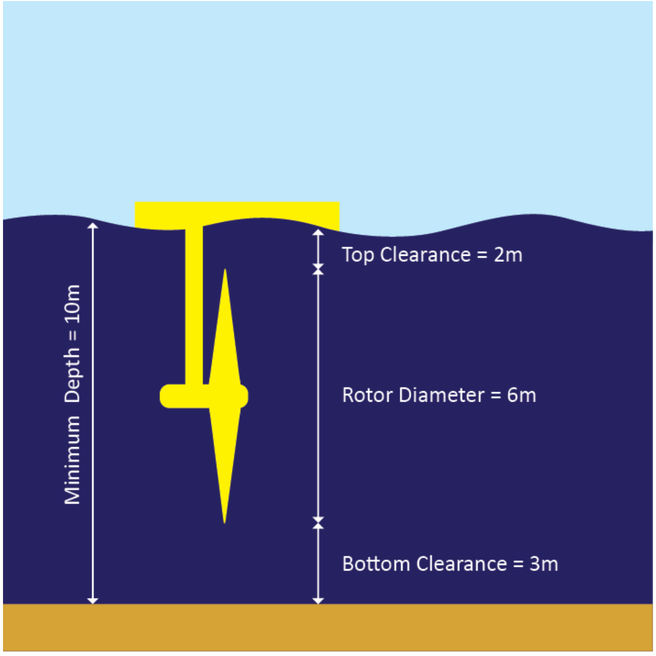

Figure 23: Example 6 m diameter floating turbine

Description:

Equivalent counterparts to MW scale floating technologies based on a moored support structures with 1 or more turbines mounted below or as part of the main structure. Technologies are designed with smaller rotor diameters of 2-6 m allowing for ease of handling and transport.

Pros:

- Device handling and recovery possible with smaller vessels
- Components may be regularly serviced and inspected at quayside
- Annual maintenance possible close to shore if cranes and covered storage allows

Cons:

- Higher potential for navigation impacts around the device
- Device subject to wave loading if installed at an exposed site
- Care required in maintaining mooring points and condition of shackles

Infrastructure Requirements:

- Berth water depths of > 5m for potential offshore construction/installation vessels (device may require more)
- Heavy lift capacity up to 80 tonnes (including major foundation/mooring components)
- Sufficient pier loading capacity
- Quayside storage and workshops
- Berth exclusivity required for periods of construction/mobilisation/installation
- Exclusive quay space area required in the region of 500 sq.m with a berthing face to handle vessels approximately up to 75m in length

Socio-economic considerations:

- Intrusion of small-scale construction activities within small communities
- Local community inclusion/exclusion within the required supply chain
- Conflict with other port stakeholders where infrastructure resources are limited
- Benefits of infrastructure developments to other port users and vessel operators
- Internal transport infrastructure interface

Example Devices:

Evopod, Nautricity (in current configuration)

6.4.6 Summary

Table 5 below provides a comparison of the device categories and selection considerations.

Table 5: Comparison of device categories

Category / Device	Seabed (MW)	Floating (MW)	Surface Piercing (MW)	Seabed (kW)	Floating (kW)
Rating Range	1MW+	1MW+	1MW+	50-250kW	50-250kW
Mooring	Seabed mounted	Floating structure	Surface piercing pile	Seabed mounted	Floating structure
Suggested Spring Velocity required	6-8 knots	6-8 knots	6-8 knots	6+ knots	6+ knots
Rotor Diameter	16m	16m	16m	6m	6m
Seabed Clearance	5m	5m	5m	2m	3m
Surface Clearance	10m	5m	5m	3m	2m
Overall Depth required	31m	31m	26m	10m	10m
Generation equipment	Below surface	Above surface	Above surface	Below Surface	Above Surface
Seabed works	Levelling for gravity base/pin piling	Embedment or drag anchors	Drilled piled or drilled pin piles	Levelling for gravity base/pin piling	Embedment or drag anchors
Installation	Limited local works content	Local works content if harbour available	Limited local works content	Local works content	Local works content
Servicing	Limited opportunity unless harbour facilities allow	Requires adequate fendered workspace	Dependant on quayside craneage to recover nacelle	Dependant on harbour facilities for recovery vessel	Dependant on water depth at quayside
Exclusion zone potentially required	Possible dependant on weather and vessel	Yes	Yes	Possible dependant on weather and vessel	Yes
Wave loading	Reduced due to install depth	Serious consideration	Serious consideration	Reduced due to install depth	Serious consideration
Berthing depth	>6m	>6m	>6m	>5m	>5m
Quayside lift	200 tonnes	100 tonnes	400 tonnes	200 tonnes	80 tonnes
Quayside laydown	1,000 sq m	1,000 sq m	1,000 sq m	500 sq m	500 sq m
Berth facing quayside	125m	75m	100m	75m	75m

7. SUPPLY CHAIN, VESSEL AND PORT CONSIDERATIONS

7.1 Overview

This section of the document has been written by SeaRoc Limited (SeaRoc). The advice below considers the broader, generic infrastructure and supply chain requirements necessary to sustain a campaign of offshore development. Consideration of existing port and vessel infrastructure available to a community development is important in the early stages of project development. Proposing strategies to allow communities to take advantage of the development opportunities is one of the first steps towards instigating investment.

7.2 Port Infrastructure

Whilst offshore construction is inherently complex in terms of the multitude of disciplines required to work within the marine environment, ultimately there are some very simple questions worthy of consideration in respect of the infrastructure requirements needed to support a particular course of development activity; for example,

- what are the available depths of water at existing port facilities at all states of tide?
- What are the quayside capacities needed to sustain a construction project, both in terms of the land area required and also pier load bearing?
- How does the project interact/conflict with other port users and how can the use of limited resources be structured for multi-user activity?

By addressing such questions, community developers are able to assess port assets in order to both consider the location of their front-line deployment and mobilisation bases, as well as determine what floating assets (vessels barges etc) will be necessary in order to maintain a construction project offshore.

The list below highlights some of the key 'question' areas that should be examined in relation to port infrastructure requirements for a marine tidal energy project of any scale:

- Navigable draft entering the port at all states of tide;
- Under keel clearance restrictions;
- Depth of water at berth at all states of tide;
- Exposure of the intended berth to certain weather conditions;
- Length of berth and fendering of the berthing face;
- Suitability of the port for long-term use;
- Port hinterland facilities;
- Intermodal connectivity between methods of transport (e.g. between road and sea transportation);
- Maximum quayside loading weight;
- Crane availability;
- Port expansion potential;
- Spare port capacity;
- Quayside storage capacity;
- Local skilled personnel for fabrication/light engineering tasks.

The supply chain requirements for all marine operations need to consider both onshore and offshore requirements.

7.3 Supply Chain Requirements

The supply chain requirements for all marine operations need to consider both onshore and offshore elements.

The ability to meet a project's supply requirements will be heavily influenced, not only by the location of the device installation, but also the location chosen for the mobilisation and pre-commissioning base and more latterly the project Operations and Maintenance (O&M) requirements.

The following figures and tables represent generic services that any developer should seek in profiling both onshore and offshore marine operations. Whilst human resource skill-sets and vessel assets are reasonably free to transfer between locations in terms of mobility, developers should also seek to consider the requirement for rigid (fixed) assets such as storage and quayside facilities as well as the more specialised onshore services such as crane operators, engineering facilities and specialised offshore services, such as commercial diving contractors and ROV operators.

Figure 24: Marine operations supply chain – onshore

Table 6: Marine operations supply chain - onshore

Port Authority/Pier Owners	Provision of quayside facilities, secure quayside areas, harbour management, vessel refuelling and water supply facilities, garbage reception facilities.
Port Stevedoring Services & Marine Agency Services	Port labour providing vessel line handlers, cargo operatives for loading and discharging delivery and installation vessels (including slinging and securing of heavy lifts)
Storage, Workshop and Office Facilities	Open storage for major components such as foundations, nacelles and blade assemblies prior to assembly and installation vessel(s) load-out, O&M operations. Closed (covered) facilities for workshop areas, secure storage of high value components and O&M operations. Office facilities for project administration and control.
Local Contractors (Electrical/Engineering)	Localised electrical & engineering firms providing on-site support to include developer requirement for planned and contingency services. Supply of raw and specialized materials to support project requirements. Servicing of on-site mechanical, hydraulic and electrical equipment.
Local Contractors (Haulage)	Movement of project components to/from construction, assembly, and installation locations. Removal of project generated waste.
Local Contractors (Lifting Services and Lifting Gear)	Crane provision for component part assembly, load out of ungeared vessels.
Local Contractors (Equipment Hire)	Tool-hire, plant hire, generators, scaffolding.
Local Contractors (Civils)	Upgrading of infrastructure to meet project requirements. Supply of plant and building materials.
Accommodation Requirements	Supply of accommodation and catering/welfare facilities for site contractors.

Figure 25: Marine operations supply chain – offshore

Table 7: Marine operations supply chain - offshore

Port Authority/Pier Owners	Harbour conservancy, maintenance of navigable depths.
Vessel Owners/Contractors	Provision of survey, construction, installation, cable laying and O&M vessels with/without offshore lifting capability. Vessels suitable for working in tidal environments. Offshore personnel transfer vessels.
Towage Services	For vessel berthing and offshore installations.
Marine Construction Teams/Offshore Riggers/Vessel Crews	Personnel qualified by both experience and legislative health and safety requirements to engage in offshore construction operations.
Offshore Survey Team	Metocean data collection, mammal and bird surveys, geophysical and geotech services, coring services, vessel-positioning survey.
Diving Contractors	For diver intervention work on installations, vessel inspections, equipment recovery, underwater video/photography.
ROV Contractors	Provision of survey and work class ROV's.
Cable Contractors	Provision of submarine cable and jointing to feed to shore sub-station and inter-array connectors
Connector Suppliers	Highly specialised wet/dry mate connectors for installation of submarine devices.

Marine Surveying and Local Specialist Marine Advisors	Used for insurance purposes, vessel audit requirements, and client representation. Local knowledge of installation waters.
Mooring Chain and Buoy Suppliers	Provision of temporary moorings, marking of installations.
Offshore Lifting Gear Supplies	Specialist slings and lifting gear for working sub-surface in high-energy tidal environments. Provision of sub-surface hydraulic and ROV operated shackles and pins.

A number of major identifiable gaps and risk factors in the supply chain are summarised below. All will have a potential degree of criticality to a project, with some being weighted more heavily than others, depending on the specific characteristics of the size of device/installation method required:

- Ability to supply installation and/or construction vessels for the project;
- Cost of specialist offshore vessels needed to meet the project specific requirements;
- Any restriction to charter parties and lease agreements offered by vessel owners;
- Ability to supply non-specialist installation vessels at short notice;
- Ability of vessels to complete operations within project time constraints;
- Ability of offshore vessels to meet owner-claimed operational criteria;
- Any tidal restrictions placed on berthing certain vessel sizes at chosen ports;
- Adequacy of localised skill-base for specialist services such as commercial diving, engineering etc.;
- Potential need for out-sourcing services out with local community to avoid monopoly issues.
- Demand for quay space and warehousing required from other marine users;
- Availability of onshore lifting capacity;
- Costs of transport logistics to bring component parts to the deployment/commissioning base;
- Ability to supply highly unique, major component part replacements at short notice;
- Availability of specialist components leading to high cost exposure;
- Vessel fuel costs due to large offshore distances or types of offshore vessel employed;
- Cost of personnel transfer to/from sites both onshore and offshore.

8. SOCIOECONOMIC CONSIDERATIONS

This section gives some consideration to the socio-economic gains that can be supported in engaging with a wave or tidal project.

8.1 Potential Socioeconomic Gains

Port infrastructure and required levels of investment are generally area specific, as are labour supply chain opportunities. Infrastructure development will, however, act as a key driver in the ability to facilitate a project and subsequent need to attracting necessary skilled labour. Figure 26 below identifies the likely 'key area' job opportunities that would be supported and potentially created as a direct result of a wave or tidal device installation project.

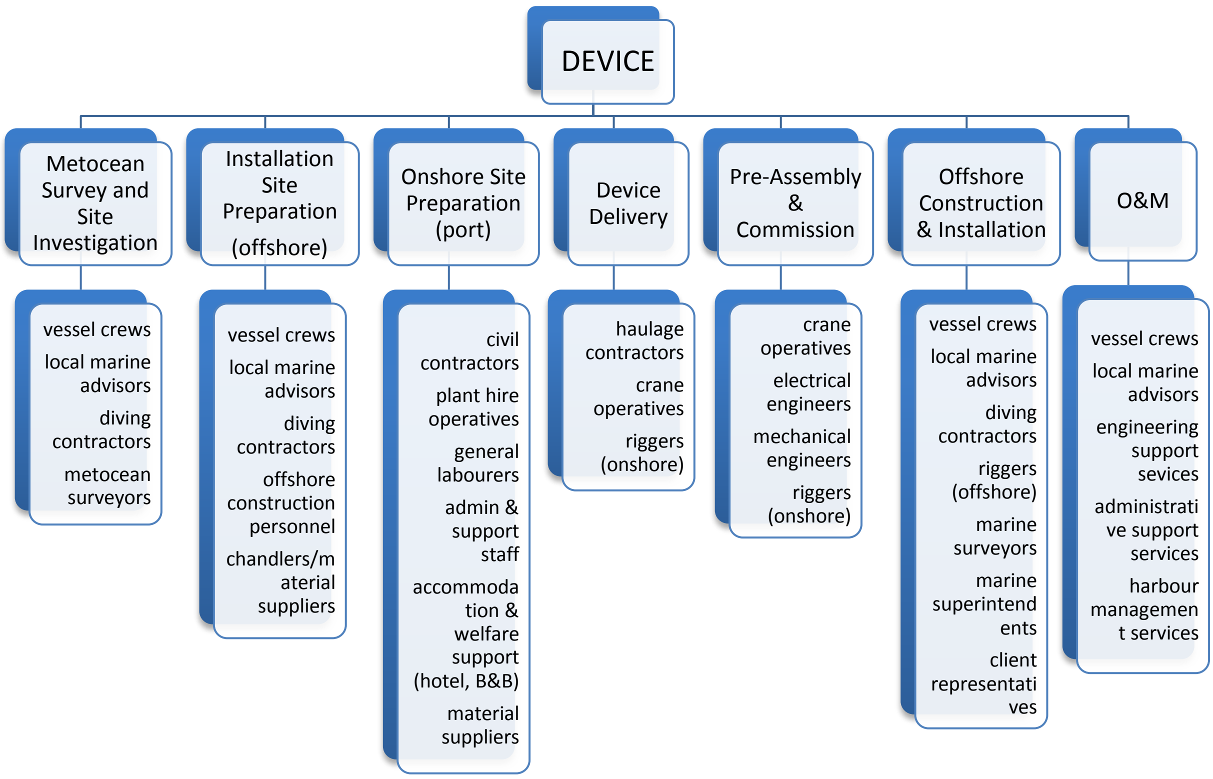

Figure 26: Potential employment opportunities as a result of deployment

Experiences from the growing wave and tidal industry on Orkney have shown that local firms are well suited to participating within both small and large offshore construction projects on the basis of a 'can-do' attitude. Within Orkney local interests have seen to be extremely flexible in their ability to work on particular projects and there is no reason to believe that other coastal communities would not be able to respond in a similarly positive manner.

Given the high level of capital investments that are required for supplying the necessary project equipment, any growth of local businesses and services to supply the tidal industry in a small community is likely to be organic in nature, being demand driven as growth opportunities present themselves. One key area however for early participation offshore is the provision of smaller vessels. The demand for vessels from an early stage of a tidal project, especially of a size and characteristic that are able to operate within the existing port infrastructure presents in itself a good opportunity for local business to become involved at an early stage. Combine this with an ability to provide surveying, diving and limited, smaller offshore construction work the attractiveness for outside companies to use locally based firms becomes obvious when placed against the high-cost of bringing in services from further afield. By vessel provision alone, opportunities will exist for local businesses to engage with offshore projects and then for themselves to combine or diversify away from participation in established local industry such as fishing. Increased use of vessels will in itself stimulate the demand for onshore vessel support services provided by localised mechanical and electrical firms.

Orkney has over the last five years seen significant investment by local vessel owners, from modest starts establishing businesses that are capable of providing a level of support to a wide range of wave and tidal clients by utilising smaller offshore support vessels such as multi-cats, fast workers and rigid inflatables. If developers and projects can be encouraged to share local resources rather than employing external service suppliers, then this further helps to stimulate the local demand.

Local business interests will increase in confidence in their expectations that participation within a burgeoning tidal industry will provide them with a suitable return on their investments. Vessel owners in particular will gain by experience in the participation of offshore construction projects and will make investments with a view to supplying vessels not only capable of working on local based projects but also those further afield. This would allow vessels to remain fully utilised during project O&M periods when the demand for vessel use locally may be more sporadic.

O&M work agreements or contracts with developers will provide the level of security that local service suppliers will require and will allow these suppliers then to make further investment for the supply provision of future tidal projects.

8.2 Further Socioeconomic Study

Following an initial feasibility assessment and decision to progress with a wave or tidal development, it is recommended a fuller socio-economic study is commissioned. Initially this would characterise the baseline environment and identify areas for local businesses to engage, invest and benefit from any opportunities.

A typical baseline socioeconomic assessment would consider:

- Population and its structure;
- Industry and employment;
- Economic activity, including tourism and recreation;
- Education and skills base;
- Housing, Transport and access to services;
- Quality of life.

Following identification of the scale and characteristics of the proposed development, an assessment would begin to identify the key potential socio-economic impacts (positive and negative) of each phase of the proposed development (from consenting, through construction and deployment to operation).

9. CONSIDERATION OF FINANCE AND FUNDING

9.1 Finance

9.1.1 Overview

For any community group progressing a wave or tidal development, a careful consideration of the financial challenges, risks and rewards is required. As the wave and tidal industry are in an early stage of development, there is limited information available on the comparative costs of energy and any information is likely to change as the industry matures. A summary of publically available data is provided in the reference section.

Tidal stream energy technology is as yet unproven on a commercial scale and has not secured the level of technology readiness, series production, market stability and scale required to attract traditional project finance debt from lenders. This is in contrast with onshore wind energy projects, which are viewed by debt providers as being a more mature and proven investment, with a level or risk that is understood and mitigated.

Indeed within the banking and investment communities, although it is generally acknowledged that the UK has an excellent wave and tidal resource to exploit, a number of concerns are apparent (DECC, 2010a):

- For banks, the sector is small and fragmented however some are watching it with interest;
- Corporates have varied and well informed opinion, but note that the sector is promising but at an early stage;
- For venture capital firms, the perceived timescales of the investment opportunity does not match the requirements of their funds.

In cognisance of the above, and given the relatively early stage of technology and project development in the wave and tidal industry, it is considered likely that all early tidal energy arrays will be financed from balance sheet by utilities, device developers or large independent power producers (or partnerships between the same).

It should be recognised therefore that communities seeking to establish an interest in tidal energy projects are unlikely to attract providers of traditional infrastructure or power market debt, but instead will be reliant on investment from the types of organisations listed above.

Capital costs of wave and tidal energy projects are currently relatively high compared with offshore and onshore wind. However, as outlined in the Renewables UK State of the Industry report (ReUK, 2013), there are good reasons for expecting these costs to fall significantly. As devices are developed and manufacturing processes are industrialised, costs will fall. Industry learning and technical innovation will also lead to a reduction in costs.

This section provides communities with an overview of the available support mechanisms, comparative costs of energy, finance challenges and indicative project costs.

9.1.2 Renewable Obligation Certificates and Feed in Tariffs

The Renewables Obligation is the main support mechanism for renewable electricity projects in the UK. It places an obligation on UK electricity suppliers to source an increasing proportion of electricity they supply to customers from renewable sources. There are three obligations within the UK, covering England and Wales, Scotland and Northern Ireland. Renewable Obligation Certificate (ROCs) are green certificates issued by Ofgem to operators of accredited renewable generating stations for the energy they generate.

The number of ROCs issued to each generator is calculated according to:

- The type of technology it uses (each type falls under a 'banding level' indicating the number of ROCs issues per MWh generated);
- The amount of electricity it generates.

Banding levels are subject to government review and current levels are displayed in Table 8 (DECC, 2012a).

Table 8: Current ROC banding levels

Technology	Banding level (ROCs/MHh)
On-shore wind	0.9
Offshore wind	2 in 2013/14; 1.9 from 2015/16 and 1.8 in 2016/17
Tidal stream	5 up to a 30MW project cap, 2 above the cap.
Wave	5 up to a 30MW project cap, 2 above the cap.

The banding levels clearly demonstrate both the level of support provided to tidal and wave developments by the government, as well as the level of support required to underpin an industry at an early stage with high costs of energy.

The Feed-in-Tariff scheme (FITs) is an environmental programme introduced by the government to promote widespread uptake of a range of small-scale renewable and low-carbon electricity generation technologies. Following a refinement of the definition of terms associated with the FIT legislation, a 'hydro generating station' includes tidal mills and locks and may be eligible for FIT (DECC, 2012b). Information on the current rates can be found on Ofgem website[39].

9.1.3 Cost of Energy

A primary measure of cost effectiveness used in the energy industry is the Levelised Cost of Energy (LCoE). It defines a unit cost for electricity by dividing total energy production by the costs involved in developing projects. The true LCoE for wave and tidal energy is uncertain, due to lack of full scale arrays.

Costs of energy figures are provided for onshore and offshore wind for ease of comparison. Analysis suggests that LCoE of onshore wind ranges in 2010 from 7.5p-12.7p/KWh (DECC, 2011), with minimal reduction by 2020 due to the mature nature of the technology.

Current costs of wave and tidal energy are estimated at 35-40p/kWh for wave and 20-30p/kWh for tidal, compared to 14-18p/kWh for offshore wind (Carbon Trust 2012b).

Using detailed technical resource work and consideration of key practical constraints, the UK's practical annual energy production from tidal stream is estimated at c.20TWh/y with an associated average cost of energy of c. 21p/kWH (Carbon Trust, 2011b).

Cost estimates are often provided over three stages of industry development: pre-demonstrations, 'first farm' 10MW arrays, and finally commercial projects (e.g. a 10MW project after 10-50MW has been deployed elsewhere).

Pre-demonstrations costs for wave are estimated at 47-65p/kWh and tidal are estimated at 30-50p/kWh (DECC, 2010c).

[39] http://www.ofgem.gov.uk/Sustainability/Environment/fits/tariff-tables/Pages/index.aspx

Benchmark costs for 'first farm' costs, which are often assumed to have a capacity of 10MW after around significant previous installation, place wave cost of energy at 38-48p/kWh and tidal energy at 29-33p/kWh (Carbon Trust, 2011a). Separate analysis on wave estimates 34-47p/kwh and for shallow (<40-50m water depth) tidal stream costs estimates 14-21p/kWh at demonstration (DECC, 2010c). Tidal costs presented by the Carbon Trust reflect leading tidal device concepts at medium and high energy sites with depths of around 30m, while wave costs are more difficult to analyses due to the number of energy extraction concepts and lack of costs for full scale devices. Data gathered by Renewables UK broadly agrees with that of the Carbon Trust and DECC, and predicts an LCoE of 30-48 p/kWh for wave and 25-38p/kWh (ReUK, 2013) for tidal.

With sufficient innovation, costs of energy are estimated to reduce to around 28p/kWh for wave and 16p/kWh for tidal by the time 800MW of capacity is installed in the Pentland Firth and Orkney Waters (Carbon Trust, 2011a). Other estimates place the reduction in costs by 2050 to 7-10p/kWh for wave and 10-15p/kWh for tidal (DECC, 2010c). Over the long timescale of 2050, the costs are estimated to fall to a level comparable with nuclear and fossil fuels with CCS (c. 6p/kWh) (Carbon Trust 2012b).

9.1.4 Indicative Project Costs

In addition to publically available estimates of the costs of energy, a number of sources provide estimates of the capital and operation expenditure required for wave and tidal projects. Given the early stage of the industry, the sources of information available, and the different methodologies employed in the analysis, the figures below should be considered as illustrative. A summary of the figures is provided as an indication to communities of the costs involved, and the full reports should be referred to for methodology and qualifications.

Table 9: Wave (commercial project costs for developer's 10 MW project after 50 MW deployed)

Source	DECC, 2010b	ReUK 2011 (first 10MW array)
Capex	£2.8m - £3.9m/MW	£4.2m - £8.4m/MW
Opex/Year	£0.17m - £0.24m/MW	£0.09m - £0.42m/MW

Table 10: Tidal (commercial project costs for developer's 10 MW project after 50 MW deployed)

Source	DECC, 2010b	ReUK 2011 (first 10MW array)
Capex	£2.7m - £4.0m/MW	£4.2m - £8.4m/MW
Opex/Year	£0.09m - £0.19m/MW	£0.09m - £0.42m/MW

During a project lifetime, the majority of the costs are associated with the device manufacture, installation and commissioning, and operation and maintenance. Analysis of the Kyle Rhea project (BVG Associates, 2011) estimates the total cost of construction at over £35million with a further operational cost of over £15million over the operation lifetime. Figure 27 shows the anticipated expenditure at Kyle Rhea, which should be noted are estimates only and may vary.

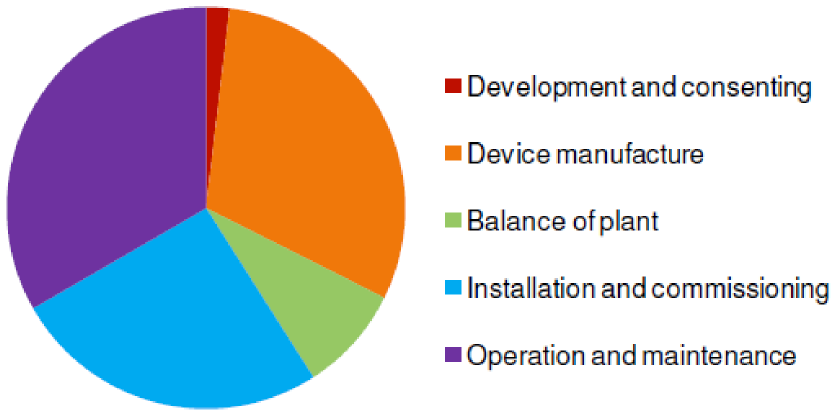

Figure 27: Breakdown of expenditure for a tidal deployment (BVG Associates, 2011)

9.1.5 Indicative Costs of Progressing a Site to Consent

As noted above, the process of developing a wave or tidal development from concept to consent can be lengthy and costly. To provide communities with an indicative idea of the level of costs involved, estimates have been provided in Table 11 for each stage. Please note that these are indicative costs only, and are highly dependent on site specifics.

Table 11: Indicative costs by stages of development

Stage of development	Indicative cost range
Feasibility Assessment	£30 – 80k
Grid Initial Study	£5 - 10k
Detailed Resource Assessment	£20 - 50k
Initial Engineering Study	£40 - 60k
Screening and Scoping of EIA	£25 - £50k
EIA process, surveys, ES production and application for Marine Licence	£750k - £2mil

9.1.6 Cost Estimation Tools

As part of the Marine Energy Challenge, a cost estimation spreadsheet was developed by the Carbon Trust (Carbon Trust, 2006). It defines a list of cost and performance paramaters and combines them into a discounted cash flow calculation, giving a cost of energy at a pre-determined project rate of return. It is a simple model, sufficient for initial assessment of device technologies on a comparative basis.

9.2 Funding

The following section has been compiled by IET. The Scottish Government has stated that it is committed to the development of Community Renewable Energy Projects and has a target of 500MW community and locally-owned renewable energy by 2020. Support to achieve this aim is available in a range of programmes including CARES, REIF and the Coastal Communities Fund.

9.2.1 CARES Feasibility and Start Up Grant

The Scottish Government's CARES 'Start Up' Grant has been designed to help community groups get started on the road to renewables. It can be used to examine feasible options in the local area, to learn what other groups have undertaken or to develop an investment plan for a community benefit income stream from a local renewable energy project. The maximum application per group is £10,000.

Projects may include:

- Start up costs for community renewable organisation;
- Community consultations and community investment plan for income from renewable energy;
- Early stage feasibility work to determine the possibility for community owned renewable energy schemes in the area or to explore opportunites to secure a stake in a commercial scheme;
- Travel expenses to visit other community groups to learn about their projects.

9.2.2 CARES Pre Planning Loan Fund

The Pre Planning Loan fund provides aims to reduce the barriers to communities who want to develop renewable energy generation projects. The loans must be repaid if the project is successful but if the project fails at the planning stage the loan can be written off. This helps to reduce the risk from the early stages of a project when other sources of funding would be unavailable. The maximum loan is currently £150k per applicant. The interest rate will be 10%p.a. It will be at the discretion of Scottish Government as to whether CARES loan could be used for a wave and tidal energy related project, given the early development stage of the industry.

9.2.3 CARES Infrastructure & Innovation Fund

A limited grant fund is available for communities to investigate and develop projects that link local energy generation with local energy use, or projects that wish to develop innovative distribution network connections.

9.2.4 Renewable Energy Investment Fund (REIF)

REIF is a loan that can be used at the post-planning stage and can be used to make up the gap between commercial borrowing and project costs. REIF is administered by the Scottish Investment Bank on behalf of the Scottish Government and CES helps with the project development and application process.

More information is available on the CES website[40].

9.2.5 Big Lottery

Big Lottery administer both the Coastal Communities Fund but also the Growing Community Assets programme.

9.2.6 Coastal Community Fund

The Coastal Communities Fund (CCF) is funded by the UK Government based on money generated by the Crown Estate's marine assets. It aims to encourage the economic development of UK coastal communities by giving them funding to create sustainable economic growth and jobs. Funding awards of over £50,000 are available for projects lasting up to two years.

9.2.7 Growing Community Assets (GCA)

Growing Community Assets (GCA)[41] is part of the BIG Lottery's Investing in Communities programme. It focuses on providing funds to allow communities to have more control or ownership

[40] http://www.communityenergyscotland.org.uk
[41] http://www.biglotteryfund.org.uk/prog_growing_community_assets.htm

of physical assets. With respect to marine renewables this may include land, buildings or harbour infrastructure.

Community Energy Scotland provides free advice and support to successful GCA applicants who are working on community renewables projects.

10. RECOMMENDATIONS

A number of key recommendations for communities considering a wave or tidal development have be drawn from the detail set out in this document. As follows:

- A central difference between community marine energy projects and conventional commercial developments is the opportunity to secure socio-economic as well as financial benefits in the eventual operation of any project.
- While there is government support for community ownership of renewable projects, and clear local socioeconomic benefits, careful consideration of all options open to a coastal community and the risks and challenges with progressing a wave or tidal development is recommended.
- A thorough and unbiased feasibility assessment is recommended at an early stage of consideration of any potential project.
- Determination of the available energy resource is essential to building a feasible project with a realistic cash flow. This should be carried out early in the process.
- The licensing and consenting process for wave and tidal developments can be involved and potentially expensive, however Scotland offers a world leading system through Marine Scotland and The Crown Estate for streamlined development.
- As part of the licensing and consenting process, early consultation with key stakeholders is recommended.
- Grid connection availability and cost should be considered early in the feasibility assessment.
- While a technology neutral approach is an option for a community development, when selecting a technology there are certain criteria that should be followed in order ensure the most appropriate device or group of devices is selected for the proposed project.
- Consideration must be given to the engineering feasibility of the project whether through desktop studies in the first instance or through carefully planned surveys and analysis at a later stage.
- Consideration of existing port and vessel infrastructure available to a community development is important in the early stages of project development as this is a clear area for socioeconomic benefits.
- A dedicated socioeconomic assessment is recommended to quantify the baseline environment and identify opportunities for investment and benefit.
- In conjunction with consideration of site feasibility and device selection, finance and funding are important elements. As the industry is in early stages of development, the true cost of energy is not refined and is currently higher than other renewable technologies.
- There is a wealth of public documents available to provide advice, information and support for wave and tidal developments.

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APPENDIX 1: GLOSSARY

Capex: Capital expenditure

CPA: Coast Protection Act 1949

DECC: Department of Energy and Climate Change

DNO: Distribution network operators

EIA: Environmental Impact Assessment

ES: Environmental Statement. Document produced on the environmental impact of a project when required under the EIA Directive.

FEPA: Food and Environment Protection Act 1985

HRA: Habitats Regulations Appraisal

JNCC: Joint Nature Conservation Committee. It is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation. It has responsibility for the provision of nature conservation advice in the offshore area beyond 12 nm from the coastline to the extent of the United Kingdom Continental Shelf (UKCS). It is a statutory consultee for s36 consent and MS is likely to consult JNCC for ML applications beyond 12nm.

kW: Kilowatt (1000watts)

LPA: Local Planning Authority

MCA: Maritime and Coastguard Agency. It is a statutory consultee for MLs and ensures navigational safety of the marine environment.

MCAA: Marine and Coastal Access Act 2009

Mean Low Water Springs (MLWS). This is the lowest level that a spring tide will drop to on average over a period of time. It will change over time, similar to MHWS.

MHWS: Mean High Water Springs. This is the highest level that spring tides reach on average over a period of time. It changes over time as land is lost to, or reclaimed from, the sea. The marine licensing system applies below MHWS.

ML: Marine Licence. Licence issued under Part 4 of the Marine (Scotland) Act 2010 or under Part 4 of the Marine and Coastal Access Act 2009.

MMO: Marine Management Organisation. Works primarily in English waters towards sustainable development in the marine area, but will work closely with Marine Scotland

MOD: Ministry of Defence

MS: Marine Scotland. MS is the directorate of Scottish Government (SG) responsible for marine and fisheries issues in Scotland.

MSA: Marine (Scotland) Act 2010

MSLOT: The Scottish Government Licensing Operations Team. They are the Government department responsible for the impartial assessment of applications, ensuring compliance with relevant legislation and issuing of all marine related permissions. It operates the 'one-stop-shop' for the consenting and licensing process.

MSPP: MS Planning and Policy. They provide independent policy advice to MSLOT, and produce licensing and policy guidance.

MSS: Marine Scotland's Science team. They provide specific science based advice to MSLOT.

MW: Megawatt (1000,000 watts)

NLB: Northern Lighthouse Board. It is responsible for advising on all buoys, lights and other marking requirements and is a statutory consultee for MLs.

Nm: Nautical mile.

NNR: National Nature Reserve. Site designated by Scottish Natural Heritage under the Wildlife and Countryside Act 1981 to protect nationally important natural and semi-natural ecosystems. (All NNRs are also SSSIs)

Opex: Operating expenditure

ReUK: RenewableUK. The UK industry trade organisation.

ROC: Renewable Obligations Certificate

S36: Section 36 of the Electricity Act 1989.

SAC: Special Area of Conservation. Site designated under the 1992 EC Habitats Directive to protect wildlife and habitats listed as being of European importance.

SEA: Strategic Environmental Assessment

SEPA: Scottish Environment Protection Agency. A statutory consultee for both s36 and ML and a regulator who's role is to protect the environment.

SNH: Scottish Natural Heritage. Independent statutory advisors on nature conservation out to 12 nm limit. SNH advise on sectoral marine plans and development applications and is a statutory consultee on s36 and ML.

SPA: Special Protection Area. Site designated to protect certain rare or vulnerable bird species under the 1979 EC Birds Directive, and the 1994 UK Regulations. The sites generally support significant numbers of internationally important species

SSSI: Site of Special Scientific Interest. Site designated by Scottish Natural Heritage under the Wildlife and Countryside Act 1981 to protect nationally important ecosystems. Sites are of special conservation interest, and include globally scarce habitats and geological formations as well as forna and flora.

UKCS: United Kingdom Continental Shelf

APPENDIX 2: REFERENCE SECTION

For ease of use, the reference section has been divided into several sections. Please note that some references may be applicable under more than one section.

Background

Aqua-RET E-learning Tool: Aquatic Renewable Energy Technologies (Aqua-RET) is an e-learning tool promoting aquatic renewable technologies. The tool shows how these technologies work, where and how they fit into the landscape, and how they benefit the economy. http://www.aquaret.com/

PRIMaRE: The Peninsula Research Institute for Marine Renewable Energy is a centre of excellence delivering world-class research and technology transfer in marine energy. It has a number of factsheets and research programmes across a wide range of topics relating to wave and tidal energy. http://www.primare.org

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Constraints: Ecological, Human, Grid

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Marine Scotland Science. 2012b. 'Marine Scotland Interactive (MSI)' provides access to spatial data held by Marine Scotland, including survey and monitoring work. Available at: http://www.scotland.gov.uk/Topics/marine/science/MSInteractive

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PASTMAP, a map-enabled query system for Scottish national and regional archaeological and architectural datasets. http://jura.rcahms.gov.uk/PASTMAP/start.jsp

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APPENDIX 3: CASE STUDIES

Several communities in Scotland and Canada have investigated marine renewable projects. The following is a summary of some of them along with links to further information:

Islay Energy Trust

The Islay Energy Trust (IET) started investigating tidal energy projects in 2008 and produced a detailed feasibility study into the potential for tidal energy projects in the Sound of Islay. IET signed an agreement with ScottishPower Renewables (SPR) in 2009 to provide local services to SPR's Sound of Islay project.

This collaboration has enabled IET to maximise the local benefits of the project by ensuring that local skills were used wherever possible and it is estimated that the project has brought over £350k of direct spend to Islay and Jura.

IET has continued to pursue its own tidal energy project and a Feasibility Study has been completed by Natural Power in parallel with this document.

Web: www.islayenergytrust.org.uk

North Yell Development Council (NYDC)

NYDC is working with Nova Innovation on the deployment of a 30kW tidal turbine. The turbine is planned to be installed in 2013. The project has been funded by £168,000 in grants from Community Energy Scotland and Shetland Islands Council.

Web: www.northyell.co.uk

Urras Oighreachd Ghabhsainn (Galson Estate Trust)

The Galson Trust is in discussions with developers about use of the coastal land needed to support the installation and operation of wave energy projects on the north-west coast of Lewis.

Web: www.galsontrust.com

Glenelg and Arnisdale Development Trust (GADT)

The Glenelg and Arnisdale Development Trust has been working since 2004 on the potential for a tidal energy project between Glenelg on the mainland and Kylerhea on the island of Skye.

Marine Current Turbines (owned by Siemens) have a seabed lease for the site and GADT are investigating the possibility of investing in the project

Web: www.glenelg.co.uk