Understanding opportunities for south west businesses to diversify into the marine renewable energy supply chain

Submitted by Amanda Pound to the University of Exeter as a dissertation for the degree of Master of Philosophy in Renewable Energy

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..........................................................
Abstract

In 2010 it was reported that the south west of England had an abundance of natural marine energy resources with a capacity to deliver 9.2 GW of energy, this combed with the diverse marine skills, services and facilities available in the south west supply chain, gives the south west of England a unique and significant offer to the MRE sector.

This dissertation outlines the opportunities for south west companies to engage with the marine renewable energy, by defining the requirements of the sector.

Potential supply chain company diversification methodology is outlined in a created model, and identification of methods of engagement with the sector was undertaken via the use of a questionnaire; with existing south west based marine renewable energy supply chain companies.

The dissertation is concluded with recommendations for potential supply chain companies in the south west of England wishing to engage with the MRE sector in the following categories: diversification, initial engagement and market entry.
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KTP aims to help businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK knowledge base. KTP is funded by Technology Strategy Board (along with the other Government funding organisations. The University of Exeter is a participant KTP Knowledge Base providing expertise and resources to businesses via a strategic project.

The author would additionally like to thank Cornwall Marine network (CMN), MERIFIC, Wave Hub for data supplied and to Mojo Maritime.
Authors Published Work

The author has previously published the following:

- **A review of targets, opportunities and barriers to the marine renewable energy market in the UK, with a focus on wave energy in the South West.** Published at the 2011 European Wave and Tidal Energy Conference (EWTEC).

- **MERiFIC 5.1.3 Supply Chain Regional Report (Cornwall).** Published for the Marine Energy in Far Peripheral and Island Communities (MERiFIC) project, Work Package 5: Sustainable Economic Development, Stream 5.1: Supply Chain Development (2013)
## Definitions

### List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACCIS</td>
<td>Advanced Composite Centre for Innovation and Science</td>
</tr>
<tr>
<td>BIMEP</td>
<td>Biscay Marine Energy Platform</td>
</tr>
<tr>
<td>BWEA</td>
<td>British Wind Energy Association</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
</tr>
<tr>
<td>CEERE</td>
<td>Centre of Engineering Excellence for Renewable Energy</td>
</tr>
<tr>
<td>CFD</td>
<td>Computational Fluid Dynamic modelling</td>
</tr>
<tr>
<td>CHP</td>
<td>Combine Heat &amp; Power</td>
</tr>
<tr>
<td>CM</td>
<td>Capacity Mechanism</td>
</tr>
<tr>
<td>CMN</td>
<td>Cornwall Marine Network</td>
</tr>
<tr>
<td>COAST</td>
<td>Coastal Ocean and Sediment Transport laboratory</td>
</tr>
<tr>
<td>CoE</td>
<td>Cost of Energy</td>
</tr>
<tr>
<td>CPF</td>
<td>Carbon Price Floor</td>
</tr>
<tr>
<td>DECC</td>
<td>Department of Energy and Climate Change</td>
</tr>
<tr>
<td>DMaC</td>
<td>The Dynamic Marine Component Test Facility</td>
</tr>
<tr>
<td>DP</td>
<td>Dynamic Positioning</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EMEC</td>
<td>European Marine Energy Centre</td>
</tr>
<tr>
<td>EMR</td>
<td>Electricity Market Reform</td>
</tr>
<tr>
<td>EPS</td>
<td>Emissions Performance Standard</td>
</tr>
<tr>
<td>Fab Test</td>
<td>Falmouth Bay Test Site</td>
</tr>
<tr>
<td>FiT CfD</td>
<td>Feed-in Tariff with Contracts for Difference</td>
</tr>
<tr>
<td>GBA</td>
<td>Gravity Based Anchor</td>
</tr>
<tr>
<td>GWh</td>
<td>Gigawatt hour</td>
</tr>
<tr>
<td>IiC</td>
<td>Invest in Cornwall</td>
</tr>
<tr>
<td>KTP</td>
<td>Knowledge Transfer Partnership</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilowatt hour</td>
</tr>
<tr>
<td>LAT</td>
<td>Lowest Astronomical Tide</td>
</tr>
<tr>
<td>LTT</td>
<td>Lynmouth Tidal Test Site</td>
</tr>
<tr>
<td>MCT</td>
<td>Marine Current Turbines limited</td>
</tr>
<tr>
<td>MEA</td>
<td>Marine Energy Action Plan</td>
</tr>
<tr>
<td>MEAD</td>
<td>Marine Energy Array Demonstrator</td>
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<tr>
<td>MEP</td>
<td>Marine Energy Park</td>
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<tr>
<td>MERiFIC</td>
<td>Marine Energy in Far Peripheral and Island Communities</td>
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<td>MMO</td>
<td>Marine Management Organisation</td>
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<td>MOR</td>
<td>Marine Offshore Renewables</td>
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<tr>
<td>MRDF</td>
<td>Marine Renewable Developing Fund</td>
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<td>MRE</td>
<td>Marine Renewable Energy</td>
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<td>MRPF</td>
<td>Marine Renewable Proving Fund</td>
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<tr>
<td>MWh</td>
<td>Megawatt Hour</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MW</td>
<td>Megawatt</td>
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<tr>
<td>Narec</td>
<td>National Renewable Energy Centre</td>
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<tr>
<td>NDA</td>
<td>Non Disclose Agreements</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operations and Maintenance</td>
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<tr>
<td>OPT</td>
<td>Ocean Power Technologies</td>
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<tr>
<td>OREC</td>
<td>Offshore Renewable Energy Catapult</td>
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<tr>
<td>ORRAD</td>
<td>Offshore Renewable Resource Assessment &amp; Development</td>
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<tr>
<td>OWEL</td>
<td>Offshore Wave Energy Limited</td>
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<tr>
<td>PPA</td>
<td>Power Purchase Agreement</td>
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<tr>
<td>PPE</td>
<td>Personal Protection Equipment</td>
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<tr>
<td>PRIMaRE</td>
<td>Peninsula Research Institute for Marine Renewable Energy</td>
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<tr>
<td>RED</td>
<td>Renewable Energy Directive</td>
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<td>Regen SW</td>
<td>Regen South West</td>
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<tr>
<td>RER</td>
<td>Renewable Energy Roadmap</td>
</tr>
<tr>
<td>RES</td>
<td>Renewable Energy Strategy</td>
</tr>
<tr>
<td>RO</td>
<td>The Renewable Obligation</td>
</tr>
<tr>
<td>ROC</td>
<td>Renewable Obligation Certificate</td>
</tr>
<tr>
<td>ROV</td>
<td>Remotely Operated Vehicle</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Date Acquisition</td>
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<tr>
<td>SWMEP</td>
<td>South West Marine Energy Park</td>
</tr>
<tr>
<td>SWMTF</td>
<td>South West Mooring Test Facility</td>
</tr>
<tr>
<td>TSB</td>
<td>Technology Strategy Board</td>
</tr>
<tr>
<td>TWh</td>
<td>Terawatt Hour</td>
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<tr>
<td>WEC</td>
<td>Wave Energy Converter</td>
</tr>
<tr>
<td>WTEDS</td>
<td>Wave and Tidal-stream Energy Demonstration Scheme</td>
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1. INTRODUCTION


The EU directive indicates a 15% target of all energy generation (including electricity, heat and transport) in the UK must come from renewable sources by 2020 [1]; almost a seven-fold increase in the share of renewables in a decade [1]. In order to meet the 15% target of RES, the UK will need to produce 30% of all its electricity needs from renewable sources [1]. This challenging target will most likely be achieved using electricity production from wind energy, however wind power alone will not fulfil the target quota and development of other technologies will be essential to achieve the targets; including biomass, photovoltaics and marine renewable energy (MRE).

The UK is perfectly located to exploit MRE resources: the island nation is rich in wave, tidal and offshore wind resources. The concentration of resources around the UK coast varies from; the exceptional tidal resource available in Scotland [2], the rich wave climate of the south west of England [3] and the significant offshore wind resource located around the coast of the UK, and especially off the North East coast of England [4].

The UK is currently leading in the development of MRE technologies with around 25% [5] of all wave and tidal technologies being developed in the UK, this growing market presents new business opportunities to the UK, through integration into the MRE supply chain.

The south west of England is perfectly positioned with both resource and capability to build a significant MRE industry. The south west boasts a natural MRE resource capable of delivering 9.2GW of power by 2030 [3] while also being home to a plethora of academic institutes, MRE testing facilities and supply chain companies [6].

The desire for the south west to become a leading centre for MRE technologies is also supported by the UK government.
Greg Barker MP, Minister of State for Energy and Climate Change gave a highly enthusiastic speech at Renewable UK Wave & Tidal conference 2011, regarding the coalition government’s support of renewable energy and how this government claims itself to be the “greenest government ever” [7].

Greg Barker MP went further to explicitly speak of his personal views on marine energy and its foreseeable growth in the south west. He stated “I personally see the south west as leading the way in developing Marine Energy. It clearly has the potential to be the first marine energy park given it’s unique mix of renewable energy resource and home grown academic, technical and industrial expertise in the marine energy sector” [7].

In January 2012 the South west of England was officially designated as the UK’s first Marine Energy Park [8], marking the significance of the MRE sector for the region.
2. MAIN AIM & OBJECTIVES

The aim & objectives of this dissertation is to understand the opportunities for businesses operating in the south west to engage with the MRE sector and identify best practice methods to assist companies in their decision to engage and support market entry.

Opportunities for the south west supply chain to engage with the MRE sector will be vast, requiring a diverse range of skills and services, which presents local businesses with a beneficial opportunity to engage and diversify into the MRE sector.

In the first instance currently MRE activity in the UK and the south west of England will need to be understood, in-order that requirements of the sector can be identified

This dissertation aims to provide potential supply chain companies with the tools to:

- Gain a broad understanding of the MRE sector in the UK.
- Identify diversification opportunities for their business.
- Identify transferable assets or skills, utilisable by the MRE sector
- Understand the challenges and successes faced by others working in the south west MRE sector.

The intended objective of this dissertation is to create recommendations which potential supply chain companies can undertake to assist them in diversification, initial engagement and market entry into the MRE supply chain sector.
3. LITERATURE AND CRITICAL REVIEW

3.1 STATE OF SECTOR

By April 2009 the UK had a total installed capacity of 0.5 MW from wave energy generation and 1.45 MW from tidal stream generation [9]. In October of the same year the then British Wind Energy Association (BWEA), now known as Renewable UK, published the Marine Renewable Energy – State of Industry report 2009; the paper indicated that the industry believed that by 2020 the UK could have installed 1-2 GW of marine energy projects [9].

Figure 3-1 illustrates the potential growth of the marine industry leading up to 2020 and the cumulative installed capacity that could be expected [9]. The report concluded that if the industry receives sufficient support in the early stages of development it can be possible to reach an installed capacity of 2 GW; however if the industry proceeds in its current manner then it may be difficult to achieve an installed capacity of 1 GW [9].
Update: In 2011 the UK’s total installed (grid connected) capacity for wave & tidal technology stood at 5.6MW [10], while the offshore wind industry in the UK has proven much more successful and currently has 3321 MW of installed capacity [11].

3.1.1 GLOBAL WAVE & TIDAL TECHNOLOGY ACTIVITY

The growing need to secure energy supply & reduce carbon emissions has resulted in many countries considering the potential use and benefits of wave & tidal energy generation. Figure 3-2 demonstrates the number of countries currently in the wave & tidal development market; at present the UK is leading the sector [12].

![Figure 3-2 Global Wave & Tidal Technology Activity](image)
Figure 3-3 shows that many developers working in the wave & tidal sector are still in early stage development, with few at a stage where device testing can commence, the few who are testing devices are predominantly testing in the UK which is currently capturing 83% of the wave & tidal testing market [12].

### 3.1.2 THE UK RENEWABLE ENERGY ROADMAP (RER)

The UK Renewable Energy Roadmap (RER) was published in July 2011 by the UK governments Department of Energy and Climate Change (DECC). It set out the UK’s planned route for Renewable Energy leading up to and beyond 2020 [13]. The paper concluded that 90% (mostly achieved using wind and biomass technologies) of the renewable energy generation needed to achieve set government target set would come from the following technology groups: onshore wind, offshore wind, biomass (*both electricity & heat*), heat pumps (*both air & ground source heat pumps*), marine (*wave & tidal*) and renewable transport. The remaining 10% was expected to come from; Hydro, PV and deep geothermal technologies [13].

The marine chapter of the RER (pages 58 – 66 of the roadmap) recommends the focus of government support should centre on three main topics:

- Manage the risk and cost of research, development & deployment
- Develop supply chain infrastructure
- Planning & Consent
Included in the roadmap is deployment potential for marine energy (wave and tidal) in the UK leading up to 2020, this is shown in Figure 3-4. The Graph shows an optimistic scenario where up to 3TWh could be generating in UK waters by 2020, however the pessimistic scenario suggests generation in the UK maybe as low as 0.7 TWh by 2020.

![Figure 3-4 Deployment potential up to 2020 for marine energy [13]](image)

The difference of 2.3 TWh between both scenarios illustrates the uncertainty of the sector, the RER takes a conservative decision to base the central range of the electricity generation on the pessimistic scenario suggesting generation is like to be between 0.5- 0.9 TWh by 2020. The potential for rapid growth in the sector is predicted to be seen in 2016 and beyond [13].

The RER also illustrates how wave & tidal technology is expected to develop over the next 9 years. Currently marine energy in the UK is classified as sitting in the ‘technology development’ stage; where full scale and small array deployments of 1-4 MW are expected. The next challenge for the UK wave & tidal market is to develop technology further and move into the ‘demo’ stage; where demonstration of 4-10 MW arrays is expected [13].
The deployment potential for offshore wind energy in the UK leading up to 2020 is shown in Figure 3-5. Figure 3-5 shows an optimistic scenario of up to 80TWh could be generating in UK waters by 2020, however the pessimistic scenario suggests generation in the UK maybe as low as 30TWh by 2020; this is much more optimistic than that of marine energy.

The difference of 50TWh between both scenarios is based around the need for cost reduction, the RER takes a fair decision to base the central range of the electricity generation between best and worst case scenario suggesting generation is like to be between 33-58TWh by 2020. The potential for rapid growth in the sector is predicted to be seen in 2018 and beyond [13].

The next challenge for the UK offshore wind market is to develop cost reduction techniques to offshore wind turbine deployment.
3.2 THE BUSINESS OPPORTUNITIES

The development of the MRE industry in the UK has the potential to generate economic growth, job creation and opportunities for technology and knowledge exportation.

3.2.1 ECONOMIC BENEFITS

The Carbon Trust have estimated that the global wave and tidal market potential for exploitation from UK businesses could be worth up to £340 billion by 2050, with peak annual revenue of £29 billion, of which £23 billion/annum from the wave sector and £6 billion/annum from the tidal sector [14].

A large percentage of this revenue is predicted to come from an export market, where the domestic market could be worth £2.5 billion/annum from the wave sector and £1.2 billion/annum from the tidal sector, in the period 2010-2050 [14]. If south west supply chain companies could secure 0.5% of the domestic market alone, this it could equate to revenues between £60 – 125 million/annum by 2050.

The potential export market would also include the manufacturing and supply of key device components, the potential component market for UK businesses has been estimated to be worth up to £4.5 billion/annum for wave energy devices and 1.2 billion/annum for tidal devices/turbines by 2050 [14].

The disparity between wave & tidal technologies economic potential is due to the extensive export market for wave energy technologies in comparison to the more modest export potential of tidal energy technologies; this is primarily due to limited global tidal resource suitable for exploitation.

In the south west it has been predicted that the potential Gross Value Added (GVA) generated from MRE activity could be up to £4800 million by 2035; £500m from tidal, £900m from wave and £3400m from offshore wind, with an average GVA of £240m per annum between 2015-2013 [15].

The installed cost of offshore wind farms has been predicted to be between 1.2 - 2.7 million €/MW [16] Using an exchange rate of £0.865 = €1 [17] offshore wind farms installed in the UK could incur costs of between 1 - 2.3 million £/MW.
When considering the development of the round 3 offshore wind farms in the south west costs can be predicted to be £1500-3450 million (based on an installed capacity of 1500MW) [18] for the Bristol channel and £800-2760 million (based on an installed capacity of 800-1200MW) [18] for the West of Wight, if local supply chain companies could secure 0.5% of this business it could equate to revenues between £4.5 – 17.2 million.

3.2.2 JOB CREATION

The job creation potential for the UK from the wave & tidal industry has been estimated to be up to 68,000 UK jobs by 2050, of which 48,000 could be working in the wave sector and 20,000 in the tidal sector [14].

However the majority of predicted job creation in the MRE sector is expected to be generated by a thriving export market, specifically accounting for around 70% of the predicted wave sector jobs and around 85% of the predicted tidal sector jobs, equating to 50,600 jobs [14].

If the UK does not create an effective and aggressive export market for UK based companies to access the global MRE market a maximum of 17,400 new jobs could be created for the domestic market [14].

With a high emphasis and expectation on the export market to deliver the majority of UK MRE jobs, mass job creation is unlikely to be seen until 2030 and beyond, when technologies have reached commercial stage [14].
In the south west the total job creation potential was estimated in the Offshore Renewable Resource Assessment & Development project (ORRAD) Economic report (2010) to be 5750 full time equivalent jobs between the periods 2015-2035; this Figure is based on the deployment of 9.2GW of technology.

Job roles created in the MRE sector in the South West are expected to range across the whole sector, specifically roles are predicted to include;

- Development: Any aspect of project development, assistances in securing funding, assistances in securing licences, leases and insurance.
- Mechanical & Electrical: Any aspect of engineering design, development and maintenance
- Structure: Any aspect of construction, assembly, manufacture and supplier of parts.
- Installation: Any aspect of installation and deployment, planning, vessel use and crew, ports and harbours.
- Grid Connection: Any aspect of project development to assist in securing grid connection, including working with testing facilities.
- Project Management: Any aspect of project management.

This level of job creation will only be seen in the south west if local supply chain companies diversify, engage and integrate themselves into the MRE supply chain.
3.2.3 BUSINESS OPPORTUNITIES

To allow UK businesses to fully exploit the opportunities offered by the MRE market, businesses will need to engage and embed themselves into the supply chain of the sector. This embedment will happen over time and engaging in the sector at the soonest opportunity will allow learning’s and challenges to be identified, ultimately positioning early engagement businesses as experienced experts in the field.

For many companies, transferable skills already exist within their business which can be directly applied to the MRE sector, whilst others may need some support and guidance.

Early engagement with the sector can benefit a company’s acceleration into market penetration, where industry can learn with the sector as technology evolves. Opportunities to engage with the MRE sector come through infiltrating the supply chain. The supply chain of MRE covers a multitude of disciplines including:

- Engineering
- Consultation
- Planning
- Maintenance
- Operation
- Manufacture
- Assembly
- Deployment & Installation
- Research
- Academia
- Test Facilities
3.2.4 MRE PROJECT COST BREAKDOWN

**Offshore wind**

Typical offshore wind farm project costs can be billions of pounds; a breakdown of the overall project costs (in percentage terms) can be seen in Figure 3-6 [19].

The greatest market opportunities (in economic terms) presented by an offshore wind farm project are:

1. Turbine (including tower) manufacture and supply; this accounts for around 33 % of total project costs.
2. Operation & maintenance (including Retrofit & overhaul); this accounts for around 33 % of total project costs.
3. Assembly, transport and Installation; this accounts for around 11 % of total project costs.
4. Foundation manufacture and supply; this accounts for around 9 % of total project costs.

![Figure 3-6 Typical capital cost breakdown for a 600 MW offshore wind farm](image)

**Figure 3-6 Typical capital cost breakdown for a 600 MW offshore wind farm [19]**
**Tidal**

Typical tidal turbine project costs can be a few million pounds, and at present usually consist of the installation of a single tidal turbine; a breakdown of the overall project costs (in percentage terms) can be seen in Figure 3-7 [20].

The greatest market opportunities (in economic terms) presented by a tidal turbine project are:

1. Device manufacture and supply; this accounts for around 36 % of total project costs.
2. Operation & maintenance: this accounts for around 34 % of total project costs.
3. Installation and commissioning; this accounts for around 18 % of total project costs.

![Figure 3-7 Typical tidal turbine project cost breakdown [20]](image)
Wave

Typical wave energy project costs can be a few million pounds, and at present usually consist of the installation of a single wave energy converter (WEC) device; a breakdown of the overall project costs (in percentage terms) can be seen in Figure 3-8 [20].

The greatest market opportunities (in economic terms) presented by a wave energy project are:

1. Device manufacture and supply; this accounts for around 36 % of total project costs.
2. Operation & maintenance: this accounts for around 34 % of total project costs.
3. Installation and commissioning; this accounts for around 18 % of total project costs.

![Figure 3-8 Typical wave energy project cost breakdown](image-url)

**Figure 3-8 Typical wave energy project cost breakdown [20]**
3.3 REGULATION & POLICY

The European Union Renewable Energy Directive (RED) & Renewable Energy Strategy (RES) is the highest reaching policy for the renewable energy sector, the policy sets out defined and individual targets for each member state to achieve in terms of renewable energy generation in their energy generation mix.

The aim of the policy is for the EU to produce 20% of all energy and 10% of all transport from renewable sources by 2020 [1]. The UK’s Target is set at 15% of all energy (electric, heat & transport) must come from renewable sources by 2020. The Department of Energy & Climate Change (DECC) proposed that in order to obtain the 15% target the UK would need to produce 30% of all its electricity needs, 12% of all its heat needs and 10% of its transport needs from renewable sources by 2020 [13].

Currently within the UK there are several supporting government policies to help enable Renewable energy market growth, theses fall into two categories: increasing energy generation and technology development.

3.3.1 INCREASING ENERGY GENERATION

The Renewable Obligation (RO)

The RO is the most widely encompassing renewable energy policy in the UK, covering all forms of renewable technology and relates to large scale generation (installations above 5MW), generators with an installed capacity of 5MW and below can choose either the RO or the feed in Tariff. [21]

The RO was established in April 2002 and is a pull mechanism policy designed to encourage the generation of electricity from renewable sources. All electric generators in the UK are obliged by The RO to generate a percentage of electricity from renewable sources, the percentage required is increasing each year in 2010/2011 the target was 11% [22] and will increase to 30% by 2020 [22] meeting the target of the RES. Generators prove compliance with the obligation by obtaining Renewable Obligation Certificates (ROC’s). The RO offers generators of electricity in the UK an exchange of a ROC(s) in return for each MWh of electricity generated onto the grid from a renewable source [23]. Each renewable technology type will be categorised into a technology maturity
banding, this banding will dictate the amount of ROC’s the generator will receive [23].

The current and proposed ROC banding for each of the marine renewable energy technologies is shown below in Table 3-1 [24]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Banding Stage</th>
<th>Current ROC/MWh</th>
<th>Proposed ROC/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore Wind</td>
<td>Post</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Demonstration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tidal Stream</td>
<td>Emerging</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Wave</td>
<td>Emerging</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

**Offshore wind**
The current ROC exchange rate for electricity generated from offshore wind energy is 1.5 ROC/MWh. The ROC value for offshore wind is expected to increase to 2 ROC/MWh for period 2013/2014 and then slowly decreasing thereafter, with 2015/16 offering 1.9 ROC/MWh and 2016/17 offering 1.8 ROC/MWh [24].

**Tidal**
The current ROC exchange rate for electricity generated from tidal energy is 2 ROC/MWh in the UK except Scotland where tidal energy receives 3 ROC/MWh. The level of ROC’s awarded for tidal energy across the whole of the UK is due to increase to 5 ROC/MWh in 2013 [24].

**Wave**
The current ROC exchange rate for electricity generated from wave energy is 2 ROC/MWh in England, Wales and Ireland, and 5 ROC’s/MWh in Scotland [25]. It has been proposed in the ROC banding review consultation that the level of ROC’s awarded in England, Wales and Ireland should equal Scotland, the review concludes that wave energy generation will increase for 2 ROC’s/MWh to 5 ROC’s/MWh in 2013, but will be capped at project install capacity size of 30MW [24].
Electricity suppliers are also required to prove compliance with the RO and can obtain ROC’s directly from a generator or purchase ROC’s on the open market [22]. The value of the ROC to buy or sell has stay relatively consistent over the last 10 years, with only minor fluctuation in value, Table 3-2 shown the average value of the a ROC over the last 10 years [26].

Table 3-2 ROC value 2002 - 2012 [26]

<table>
<thead>
<tr>
<th>Year</th>
<th>Average ROC value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>£47</td>
</tr>
<tr>
<td>2003</td>
<td>£47</td>
</tr>
<tr>
<td>2004</td>
<td>£49</td>
</tr>
<tr>
<td>2005</td>
<td>£45</td>
</tr>
<tr>
<td>2006</td>
<td>£41</td>
</tr>
<tr>
<td>2007</td>
<td>£48</td>
</tr>
<tr>
<td>2008</td>
<td>£51</td>
</tr>
<tr>
<td>2009</td>
<td>£51</td>
</tr>
<tr>
<td>2010</td>
<td>£48</td>
</tr>
<tr>
<td>2011</td>
<td>£48</td>
</tr>
<tr>
<td>2012</td>
<td>£44 (only 2 months data)</td>
</tr>
</tbody>
</table>

When suppliers do not have sufficient ROCs to meet their obligation, they make a payment to the buy-out fund. The money which accumulates in the buy-out fund is distributed between all suppliers in proportion to the amount of ROC submitted [22].
Electricity Market Reform (EMR)

The EMR was Published 12th July 2011 by DECC [27], the paper considered the energy supply and demand of the UK. The EMR highlighted the challenges to the UK government which included; an energy gap scenario, cost of electricity to consumers and energy security of the UK. The key measures of the paper included: attracting investment, reduce consumer bills and create a secure mix of electricity sources, including: gas, new nuclear, renewables, and carbon capture and storage. The Key elements of the paper were explored in four different packages [27];

- Feed-in Tariff with Contracts for Difference (FiT CfD)
- Carbon Price Floor (CPF)
- Emissions Performance Standard (EPS)
- Capacity Mechanism (CM)

Feed-in Tariff with Contracts for Difference (FiT CfD)

The FiT CfD will replace the Renewables Obligation from 2017 onward and will be based around long term contracts; which will provide clear, stable and predictable revenue streams for investors in low carbon electricity generation [27].

Under the proposed arrangements; Generators will sell their electricity (generated from non fossil fuel sources) on to the open market, they will receive a top-up payment if the market wholesale price is below the agreed tariff level [27]. Where the market price rises above the agreed tariff level, generators are required to pay the difference back, the repayments are then used to reduce the price passed onto the consumers.

The former is likely to be most relevant to less developed technologies which need incentives to gain economic viability; while more advanced technologies will sit closer to the payback element of the system. An indication that a technology no longer needs support through the FiT CfD will be indicted when the generator is consistently paying back to the market.

The new FiT CfD system will allow developers to precisely predict their expected revenue from planned generation in their projects, this certainty will create a clearer picture of project economics [27].
Due to differing characteristics and operation strategies of different generation technologies, they will each be incentivised differently. The main distinction is between:

- base-load generation
- intermittent generation
- flexible generation - including biomass, CHP (combine Heat & Power) and potentially new nuclear

It is proposed each scheme is offered a slightly different package [27].

The primary legislation for the FiT CfD is expected in spring 2012 [28], and the organisation to manage contracts and process is expected to be established in summer 2013 [27]. The FiT CfD contracts are proposed to be available from early 2014, in the period 2014 through to 2017 projects above 5MW will be able to choose between RO and Fit with CfD, on 31 March 2017 the RO will officially close for new registrations [27].

In the transition from the renewable obligation to the feed in traffic with contract for difference; existing projects which have been accredited by the RO will continue to be supported under the RO for their life (until RO end date 2037) and will not be permitted to transfer to the new scheme [27]. Projects which are delayed from registering for the RO before 31 March 2017 through no fault of their own may be offered a grace period for RO registration [27].

New renewable energy projects’ coming online once the FiT CfD is introduced and until 31 March 2017, will have a choice between the RO and FiT CfD. Generation for which a FiT CfD is in place will not be eligible to accredit under the RO and vice versa. The RO will close to new accreditations (and additional capacity commissioned at existing stations) on 31 March 2017, after this date all large scale (5MW +) renewable energy projects will be covered by the FiT CfD. Additional capacity of less than 5 MW which is eligible for the small-scale Feed-in Tariff will not be eligible for a FiT CfD. Sub-5 MW installations will continue to receive the existing Feed-in Tariff.
Carbon Price Floor (CPF)
The CPF aims that by placing a price on carbon there will become a stronger incentive to invest in low-carbon generation technologies, it proposes that electricity generators fossil fuels suppliers to will be taxed for the fuels that they supply, depending on carbon content of fuel [27].

Emissions Performance Standard (EPS)
The EPS will require all new fossil fuel power stations to monitor and control emissions to a limit of 450g CO₂/kWh @ base load. EPS will only apply to power plants over 50MW net capacity [29]. The EPS will not be retrospective [27].

Capacity mechanism (CM)
The proposed CM intends to incentivise additional capacity availability to the national grid, helping to cope with peaks and troughs in demand [27]. Details of how the CM will work are expected to be published May 2012 [28].

3.3.2 TECHNOLOGY DEVELOPMENT

Marine Energy Action (MEA) Plan
The Marine Energy Action (MEA) Plan sets out an agreed vision for the support of the marine energy sector up to 2030; outlining actions required by both private and public sectors to assist in achieve the targets set out in the RES [30].

The MEA deployment and technology development timescale can be seen in Figure 3-9. It can be seen from the timescale that the UK is currently (2010 – 2015) in the ‘first generation’ stage; with expected deployments of full scale devices and the beginning of small (2-10 MW) array deployments. The MEA proposes that large scale (10MW +) arrays of marine energy device are expected in UK waters in 2014 and beyond.
Figure 3-9 Wave and tidal technology deployment 2010 - 2030 [30]

The MEA also offers a £60m fund for investment in marine energy infrastructure and technology [31], of which £22m will be made available for the Marine Renewable Proving Fund (MRPF) [31].

The injection of financial support is designed to allow the sector to; test and prove devices and components as well as expand test facilities and fund deployments.

**Marine Renewable Developing Fund (MRDF)**

The Marine Renewable Developing Fund (MRDF) was set up in August 2004 with a budget of £50M [32]. The MRDF had four components;

- Wave and Tidal-stream Energy Demonstration Scheme (WTEDS)
- Environmental research
- Related research
- Infrastructure support

The WTEDS provided capital grants and revenue support to multi-device early stage commercial generation facilities. The WTEDS accounted for £42M of the MRDF’s budget [31] and was limited to £5m per project, ultimately aiming to support in excess of 8 projects.
The requirements of to achieve eligibility for the fund were set very high making it hard for developers to successfully pull down funding [32].

The MRDF closed in March 2011 [10], and was general accepted as a failure. The level of technology development needed to draw funds from the MRDF was set unequally high in comparison with technology development seen at the time [32].

**Marine Renewable Proving Fund (MRPF)**

The Marine Renewable Proving Fund (MRPF) was set up in July 2009 with a budget of £22.5m [32]. The initiative was designed and managed by the Carbon Trust and used new funding provided by the Department of Energy and Climate Change (DECC) [33].

Up to £6m was available to successful applicants to help meet the capital costs of building and deploying wave and tidal stream prototypes [34].

The MRPF was set up as an achievable stepping stone for developer to use to access the MRDF, in the first year of the support mechanism six developers have benefited from the funding [33]

**Marine Energy Array Demonstrator (MEAD)**

The Marine Energy Array Demonstrator (MEAD) fund is aimed at developing technology from prototype stage to demonstration of array of devices [35]. The fund was set up by DECC in June 2010 and consists of a £20 million fund to assist wave & tidal developers in achieving arrays of devices [35]. The fund opened in April 2012 [36] and will be used to support two projects [35].
3.4 MRE TECHNOLOGIES

There are three key technology groups included within the marine renewable energy sector, these are: offshore wind (including floating wind), wave and tidal. The following chapters describe each of the technology groups:

3.4.1 OFFSHORE WIND

Offshore wind technology has evolved from the onshore wind market; where the principle mechanical means of energy extraction are the same. There are many additional challenges when applying the onshore wind technology to the marine environment, these include: foundation installation, turbine installation, technology reliability, increased wind speeds, saline environment and the challenging weather conditions found offshore.

Offshore wind in the UK has been rolled out under the UK offshore wind development program, through three staggered rounds;

**Round 1**: shallow water depth, near shore sites, between 4-194MW in capacity, most farms are now operational [37].

**Round 2**: shallow – intermediate water depths, sites slightly further offshore, between 65-1200MW in capacity, around half of the farms are now operational [37].

**Round 3**: intermediate water depth, offshore shore sites, between 660-12800MW in capacity, currently in consenting and planning stages [37].

<table>
<thead>
<tr>
<th>Table 3-3 Categorisation of site water depth for offshore wind technologies [38]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category (offshore wind)</td>
</tr>
<tr>
<td>Shallow Water</td>
</tr>
<tr>
<td>Intermediate water wind</td>
</tr>
<tr>
<td>Deep Water</td>
</tr>
</tbody>
</table>
Round 3 of The UK offshore development program has already leased sites with a combined capacity of 31GW, construction is expected to start in 2014 [39]. With the need for further development beyond round 3, it can be expected that offshore wind projects will need to move further offshore and ultimately into deep water sites.

Once developers move to deep water sites (50m+), traditional turbine foundation technology become will no longer be financially viable for installation and therefore developers are now looking for alternative foundation methods, this has led to the very recent development of floating wind technologies [40].

Floating wind technology is the newest of the marine energy technologies; the turbine technology being used is standard offshore wind technology with highly innovative floating sections which can be moored [40].

Floating wind if successful has the largest economic potential of the entire MRE sector, this is due to: a) access to higher wind speeds (commonly found at deep water sites) and b) greater volume of operational sites (unconstrained by water depth) [40].

The basic components of a wind turbine can be seen in Figure 3-10. Direct drive technology is considered the more reliable generation method, due to the removal of the gear box, which in turn reduces maintenance requirements and is therefore more appropriate for the offshore market [41].
3.4.2 WAVE

Wave Energy is considered to be the most immature of the marine energy technologies, with few developers actually in the water. Due to the embryonic nature of wave energy technologies, device types differ widely, unlike the wind energy market there has not been a convergence of technology; creating a standardised design. Difference found in current wave energy technologies, are listed below:

- Structure material (materials used by developers; steel, composite, concrete)
- Power take off arrangements differ significantly – usually unique to individual device.
- Water column position (submerged or surface floating)
- Moorings & Foundations
- Wave technology also differs in distance offshore, and can be categorised in three groups; shore line, near shore and offshore.
Shore line technologies may include integrating the technology into existing infrastructure such as a breakwater in harbours; an example is Wavegen’s Limpet device. Near shore technologies commonly consist of onshore energy generation with the wet device simply acting as a pump, an example is Aquamarine Power’s Oyster device while offshore technologies will generate electricity far offshore (transferring power to shore via subsea cabling), an example is Fred Olsen’s Lifesaver device.

Table 3-4 Categorisation of distance offshore for wave technologies [43]

<table>
<thead>
<tr>
<th>Category (wave)</th>
<th>Distance offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore Line</td>
<td>0m</td>
</tr>
<tr>
<td>Near Shore</td>
<td>Up to 500m</td>
</tr>
<tr>
<td>Off shore</td>
<td>500m and beyond</td>
</tr>
</tbody>
</table>

Due to the plentiful availability of excellent wave resources globally and the potentially huge export market, many countries are now pursuing wave energy technology development [44].

It has been estimated that there are currently around 156 wave energy technologies in development [44]; a list of current known wave technology developers is shown in Appendix A.

The design specifics of these 150+ devices differ significantly, but commonly fall into five broad categories; Attenuator, Point Absorber, Oscillating Wave Surge Converter, Oscillating Water Column and Overtopping [44,45]

**Attenuator**

Attenuator wave energy devices are usually long multi segment floating structures oriented to face into the oncoming waves [46]. The differing heights of the device as a wave passes (trough and crest) causes flexing between each segment, this flexing is connected to hydraulic pumps or other converters [46]. Pelamis is an example of an Attenuator device [44] and can be seen in the far right image in Figure 3-11.
Point Absorber

Point Absorber wave energy devices are usually floating structure usually located at the water surface, with components that move relative to each other due to wave action [46]. The power take-off system may take a number of forms, depending on the configuration [45] common PTO include electromechanical or hydraulic energy converters. OPT’s Power Buoy device is an example of a point absorber device and can be seen in the far right image in Figure 3-12.

Oscillating Wave Surge Converter

Oscillating Wave Surge Converter wave energy devices device extracts the energy caused by wave surges and the movement of water particles within them [45]. Wave surge device usually consists of a hinged flap which oscillates, the oscillations are usually used to pump a fluid back to shore to drive hydroelectric or hydraulic generators. Due to the need for surge waves these devices will be located in near shore locations. Aquamarine Power’s Oyster device is an example of an oscillating wave surge device and can be seen in the far right image in Figure 3-13.
Oscillating Water Column

Oscillating Water Column wave energy devices are commonly partially submerged, hollow structures. The device is open to the sea below the water line, enclosing a column of air on top of a column of water. Waves cause the water column to rise and fall, which in turn compresses and decompresses the air column [45]. The compressed and decompressed air passes through a bi-directional air turbine. Oscillating water column technology can be used in either structure form located at the shore line (usually built into existing infrastructure such as a harbour breakwater) or device form located in offshore [46]. Wave Gen’s Limpet structure is an example of oscillating wave column technology used at the shore line and can be seen in the far right image in Figure 3-14.

Figure 3-13 Illustrations of oscillating wave surge converter devices (from left to right [45] [49])

Figure 3-14 Illustrations of oscillating water column devices (from left to right [50] [51])
Overtopping

Overtopping wave energy devices have reservoirs that are filled by incoming waves to levels above the ocean surface level [52]. The water captured in the reservoir is then released, and gravity causes it to fall back toward the ocean surface [52]. The energy of the falling water is used to turn low head hydro turbines [45]. Wave Dragon is an example of an overtopping device and can be seen in the far right image in Figure 3-15.

![Diagram of overtopping device](image)

Figure 3-15 Illustrations of overtopping devices (from left to right [52] [46]

3.4.3 TIDAL

Tidal energy technology is an emerging technology which is moving toward technology maturity more rapidly than the wave energy sector. Unlike wave energy technologies, tidal technologies are beginning to show signs of design convergence which is an indicator of technology maturity.

The tidal sector has had several successful full scale prototype deployments in the UK, many of which have been deployed at the European Marine Energy Centre in Scotland [53] along with one pre-commercial deployment in Strangford Loch.

The 1.2 MW SeaGen device by Marine Current Turbines (MCT) was installed at Strangford Loch, Ireland in 2008 [54]. The SeaGen is still installed in Strangford Loch, and in January 2012 had surpassed generating 3GWh onto the national grid [55].

<table>
<thead>
<tr>
<th>Category (Tidal)</th>
<th>Installation water depth (below LAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow Water Tidal Stream</td>
<td>~ 20m</td>
</tr>
<tr>
<td>Deep Water Tidal Stream</td>
<td>35m+</td>
</tr>
</tbody>
</table>
It has been estimated that there are currently around 88 tidal devise in development [58], being developed, a list of current known tidal technology developers can be seen in Appendix B.

The design specifics of these devices differ (although less significantly than wave energy devices) and commonly fall into four broad categories; Horizontal Axis Turbines, Vertical Axis Turbines, Oscillating Hydrofoil and Venturi Turbines [59].

**Horizontal Axis Turbines**

Horizontal Axis Turbines extracts energy from the moving water column in a similar way as a wind turbine [59]. This type of device tends to favour either a foundation or gravity base anchor configuration, with single or multiple turbines attached to the structure. The SeaGen and AK100 are both examples of a Horizontal axis turbine and can be seen in the far left and far right images in Figure 3-16 respectively.

![Figure 3-16 Illustrations of horizontal axis tidal turbines (from left to right [60] [59] [61])](image1)

**Vertical Axis Turbines**

Vertical Axis Turbines extracts energy from the moving column of water in a similar method to the horizontal turbine; however the turbine is mounted on a vertical axis [59]. The Blue Hydro device is an example of a vertical axis turbine and can be seen in the far left image shown in Figure 3-17.
Oscillating Hydrofoil

Oscillating Hydrofoil tidal device works by attaching a hydrofoil to an oscillating arm which is attached to a fixed foundation. The oscillation of the arm is created when the current flows over/under the hydrofoil creating up/down lift and resulting in the motion of the arm. This motion can be used to drive fluid in a hydraulic system for electricity conversion [59]. The BioSTREAM and Pulse Stream devices are both examples of an oscillating hydrofoil device and can be seen in the far left and far right images in Figure 3-18 respectively.

Venturi Turbines

Venturi Turbines require housing a turbine in a duct, the fluid flow is both concentrated and accelerated as it passes the turbine. The funnel-like collecting device sits submerged in the tidal current. The flow of water can drive a turbine directly or the induced pressure differential in the system can drive an air-turbine [59]. The Open Hydro and Rotech Tidal Turbine (RTT) devices are both examples of Venturi tidal turbine and can be seen in the far left and far right images in Figure 3-19 respectively.
3.5 MRE RESOURCE AND CURRENT ACTIVITY

The UK has a significant natural marine energy resource, with the potential to be utilised by all the MRE technologies. The energy resource of wind, wave and tide are not however uniform across the UK and therefore specific areas of the UK will have differing advantages and disadvantages when considering energy exploitation.

3.5.1 OFFSHORE WIND

*Offshore Wind Resource in the UK*

The UK has a significant natural offshore wind energy resource around much of its coast line, with the highest concentration of wind power found off the North West coast of Scotland; where annual mean wind power density has been found to exceed 2500 W/m² [67]. The site however is not currently exploitable due to the extreme water depth found at the site (in future it may be possible to exploit some of this resource through the use of floating offshore wind technologies).

Currently all existing and planned offshore wind farm sites sit within areas consisting of an annual mean wind power density of 1101-1200 W/m² or below [68,67].

A map indicating annual mean wind power density across the UK can be seen in Figure 3-20.
Offshore Wind Activity in the UK

Current offshore wind energy activity in the UK is being rolled out under two Crown Estate programs;

- The Round 3 Offshore Wind Programme
- The Scottish Offshore Wind Programme
The Round 3 Offshore Wind Programme

The offshore wind resource found around the UK will be exploited through the Round 3 offshore wind programme. The programme will see the introduction of 9 new offshore wind farm sites in UK waters, with a combine installed capacity of 25,500MW (It should be noted that Figure 3-21 has been used for illustrative purpose only, The round 3 total figure shown is incorrect and should read: round 3 total 25,500 MW) [68].

A map indicating the location of each of the nine sites and their intended installed capacity can be seen in Figure 3-21.

Figure 3-21 UK Round 3 offshore wind farm sites [68]

The three largest sites in the programme; Dogger Bank, Hornsea and Norfolk will be located off the North East of England, and account for 17,000 MW or 68% of the total installed capacity of the Round 3 offshore Wind Programme.
The Scottish Offshore Wind Programme

In addition to The Round 3 Offshore Wind Programme, Scotland will also see an offshore wind programme of its own; The Scottish Offshore Wind Programme.

The programme will see the introduction of 5 new offshore wind farm sites in Scottish waters [69], with a combine installed capacity of up to 4940MW [70,71,72,73,74].

The individual installed capacity of each of the sites is listed below:

- Argyll Array: with an expected installed capacity of 500–1800 MW [70]
- Islay: with an expected installed capacity of 690MW [71]
- Neart na Gaoithe: with an expected installed capacity of 450MW [72]
- Inch Cape: with an expected installed capacity of 1000MW [73]
- Beatrice: with an expected installed capacity of 1000MW [74]

A map indicating the location of each of the sites can be seen in Figure 3-22.

Figure 3-22 Scottish offshore wind farm sites [69]
Floating Wind in Activity in the UK
At present the UK has no commercial activity in floating wind technologies, however there are two floating wind demonstration sites in the planning for UK waters, these are;

ETI offshore wind floating system demonstration project: In February 2012 the Energy Technologies Institute (ETI) announced that it was undertaking a feasibility study at Wave Hub; to establish if the facility could be used for the deployment location of the ETI offshore wind floating system demonstration project [75].

Scotland's floating wind demonstration site: In November 2012 the Crown Estate announced its plans to develop a floating wind demonstration site off the west coast of Scotland [76]

Offshore Wind in the South West
Offshore wind in the south west is already being realised with the planned development of two offshore wind farm sites under The Round 3 Offshore Wind Programme, these sites are; The Bristol Channel (including the Atlantic Array site) and the West of Wight [68].

A map indicating the Round 3 Offshore Wind Programme sites in the south west can be seen in Figure 3-23

Figure 3-23 offshore wind farm sites in the south west [68]
The Bristol Channel zone
The Bristol Channel zone encompasses a total area of 949.7 km² and is approximately 24.4 km offshore with water depths ranging from 19.5 - 60.9 m.

In 2010 RWE npower renewables successful won a tender to build a 1500 MW wind farm called Atlantic Array within the zone [77]

The Atlantic Array site
The Atlantic Array site will have an Intended capacity of 1200 MW, and is located 16.5 km offshore from the north Devon coast [78] with water depths ranging from 25 - 60 m [79].

The West of Wight zone
In 2010 Eneco were awarded the rights to develop the 723 km² West of Wight site, of which 197 km² will be developed into a wind farm [80]. The wind farm is to be called Navitus Bay [81] and is expected to have a total Installed capacity of 900 - 1200MW [80].

Beyond the Round 3 Offshore Wind Programme, the south west offers further offshore wind resource suitable for exploitation. Potential zones for future development of offshore wind in the south west were identified under the ORRAD technical report [3], the location of these zones can be seen in Figure 3-24.

The zones indicated would require a mixture of traditional and floating offshore wind technologies if they are to achieve full capacity; this is due to the water depths found at the sites.
Figure 3-24 identifies four potential zones for offshore wind development; ‘Outer Bristol Channel’ with potential to deliver 1600MW, ‘North of the Isles of Scilly’ with potential to deliver 500MW, ‘South Cornwall Offshore’ with potential to deliver 1000MW and ‘Outer Lyme Bay’ with potential to deliver 1000MW [3].

In total the four sites have the potential to deliver a total of around 4000MW from south west offshore wind farm sites; this can only be realised through delivering 1500MW through the use of traditional offshore wind and 2500MW through the use of floating wind [3].
3.5.2 WAVE

Wave Energy Resource in the UK

The UK has a significant natural wave energy resource, the highest concentration of wave power in the UK can be found off the North West coast of Scotland, where annual mean wave power has been found to be 70.1-80.0 kW/m of wave crest [67], this site however is not currently exploitable due to the immature nature of wave energy technology and the extreme weather conditions found at the site. Current UK wave energy test sites are located within areas consisting of annual mean wave power of 10.1-30 kW/m of wave crest [67, 82, 83, 84]. A map indicating annual mean wave power across the UK can be seen in Figure 3-25.

![Figure 3-25 UK Annual Mean Wave Power Map [67]](image-url)
**Wave Energy Activity in the UK**

Current wave energy activity in the UK can be categories into two distinct categories: Demonstration and Commercial

**Demonstration**

The majority of wave energy activity in the UK is currently undertaken at test sites, where technologies can be demonstrated. There are three prominent test sites in the UK for the testing of wave energy technologies, these are;

- The European Marine Energy Centre (EMEC), Orkney, Scotland, where two wave energy test facilities are available for use; the *Billa Croo* (wave energy test site) and the *Scapa Flow* (wave energy nursery test site) [82]
- Falmouth Bay Test Site (Fab Test), Cornwall, England, where a nursery sites is available for use [84]
- Wave Hub, Cornwall, England, where array testing sites are available for use [83].

**Commercial**

In March 2010 Scotland successfully gained approval from the Crown Estate for the development of the first commercial wave and tidal sites, known as ‘The Pentland Firth and Orkney Waters Development’ [85], an image illustrating the approved sites and location is shown in Figure 3-26 (wave sites are indicted in yellow).
The Pentland Firth and Orkney Waters development will consist of 6 commercial wave sites, with the potential to deliver a combine installed capacity of 600MW, the sites included in development are:

- Farr Point, with an expected installed capacity of 50MW [85]
- West Orkney South, with an expected installed capacity of 50MW [85]
- West Orkney Middle South, with an expected installed capacity of 50MW [85]
- Brough Head, with an expected installed capacity of 200MW [85]
- Marwick Head, with an expected installed capacity of 50MW [85]
- Costa Head, with an expected installed capacity of 200MW [85]

*Wave Energy in the South West*

The potential for wave energy exploitation in the south west is already being realised with the development of two wave energy test sites; Wave Hub and Fab Test. The development of such test sites in the south west demonstrates that the natural wave resource is exploitable [83, 84]
The wave hub site has a capacity to deliver 20MW of wave energy, with the potential for this to be increase to 50M [86]. FabTest is a non-grid connected site [84].

In addition to Wave Hub and Fab Test the south west has an abundance of wave energy resource with potential for exploitation on a commercial scale.

Potential zones for future development of wave energy in the south west were identified under the ORRAD technical report [3], the location of these zones can be seen in Figure 3-27.

Figure 3-27 identifies four potential zones for wave energy development; ‘Lundy Outer Severn’ with potential to deliver 100MW, ‘North Cornwall and Devon Coastal’ with potential to deliver 540MW, ‘Isles of Scilly’ with potential to deliver 400MW and ‘South Cornwall Coastal’ with potential to deliver 200MW [3].

In total the four sites have the potential to deliver a total of 1240MW from wave farm sites [3].
3.5.3 TIDAL

*Tidal Energy Resource in the UK*

The UK has a variety of locations which offer an exploitable tidal energy resource [67], a map indicating average tidal power across the UK can be seen in Figure 3-28.

![Figure 3-28 UK Average Tidal Power Map [67]](image-url)
The most significant tidal energy resources within UK waters can be found in the Pentland Firth, Scotland and the Bristol Channel, England.

**Pentland Firth**
The Pentland Firth is located between the north cost of mainland Scotland and the Orkney Islands; the area boasts an average tidal power of 3.01-4.00 kW/m² [67].

**Bristol Channel**
The Bristol Channel runs between the coast of North Devon, England and South Wales, the area contains a varying tidal power, the majority of the channel boast an average tidal power of 0.51-1.50 kW/m² [67], there are however some area which contain an average tidal power of up to 3.01-4.00 kW/m² [67].

Other areas of the UK with significant tidal power resources include; Anglesey & St David’s head in Wales, Strangford Loch & Ballycastle in Northern Ireland and the Isle of Islay in Scotland [67].

**Tidal Energy Activity in the UK**
Current tidal energy activity in the UK can be categories into two distinct categories: Demonstration and Commercial

**Demonstration**
The majority of tidal energy activity in the UK is currently undertaken at test sites, where technologies can be demonstrated. The majority of tidal testing in the UK is undertaken at The European Marine Energy Centre (EMEC), Orkney, Scotland, where two tidal energy test facilities are available for use; The *Fall of Warness* Tidal Energy Test Site, and The *Shapinsay Sound* Tidal Energy Nursery Test Site [87].
Commercial

At present there is only one operational commercial tidal energy site in the UK, this is located in Strangford Loch, Northern Ireland and where a single 1.2 MW SeaGen tidal turbine has been installed since 2008 [54].

In March 2010 Scotland successfully gained approval from the Crown Estate for the development of the first commercial wave and tidal sites, known as The Pentland Firth and Orkney waters development [85]; an image illustrating the approved sites and location is shown in Figure 3-26 (tidal sites are indicted in black).

The Pentland Firth and Orkney waters development will consist of 5 commercial tidal sites, with the potential to deliver a combine installed capacity of 1000MW [85], the sites included in development are;

- Westray South: with an expected installed capacity of 200MW [85]
- Brough Ness: with an expected installed capacity of 100MW [85]
- Ness of Duncansby: with an expected installed capacity of 100MW [85]
- Inner Sound: with an expected installed capacity of 400MW [85]
- Cantick Head: with an expected installed capacity of 200MW [85]
Tidal Energy Activity in the South West

The potential for tidal energy exploitation in the south west has historically been realised with the Lynmouth Tidal Test Site (LTT), located off the north Devon coast [6].

In 2003 MCT installed their demonstration Seaflow tidal turbine at the LTT sites, although the project proved successful both the turbine and the test site were decommissioned in 2007. Today the newly appointed South West Marine Energy Park (SWMEP) board are working to reinstated and upgrade the LTT site [6].

In addition to LTT the south west has several locations for the exploitation of tidal energy resource on a commercial scale.

Potential zones for future development of tidal energy in the south west were identified in the ORRAD technical report [3], the location of these zones can be seen in Figure 3-29.

![Figure 3-29 potential development zones for tidal energy in the south west [3]](image)

Figure 3-29 identifies four potential zones for tidal energy development; ‘Inner Bristol Channel’ with potential to deliver 600MW, ‘Lundy and Outer Severn’ with potential to deliver 210MW, ‘Lands End Coastal’ with potential to deliver 150MW and ‘Portland’ with potential to deliver 120MW [3].

In total the four sites have the potential to deliver a total of 1080MW from south west tidal farm sites [3].
3.6 TEST SITES

The testing and demonstration of MRE technologies is key to commercialising the technology. In the last few years there has been a flurry of applications for new MRE testing site, on a global scale; primarily due to technological development towards commercial stage (demand) and individual countries desire to become involved with the MRE sector; historically the majority of MRE technology testing was carries out in the UK.

A list of current and planned testing sites can be seen below.

3.6.1 OFFSHORE WIND

**Blyth Offshore Wind Demonstration Site**

*Location:* England, Northumberland  
*Capacity:* 100 MW [88]  
*Status:* Construction and operation submitted to MMO [89]

The National Renewable Energy Centre (Narec) is developing an offshore wind demonstration site in the North Sea, off Blyth, Northumberland [89]. The site will be used for the demonstration of up to 15 pre-commercial prototype turbines, which will be constructed across three array locations; each offering different water depths ranging from 35 -58m [89].

Construction of the site is expected to start early 2014, and is due for completion by 2016 [89].

**Hunterston Test Site**

*Location:* Scotland, Ayrshire  
*Capacity:* 24 MW [90]  
*Status:* Construction commenced 2013 [91]

Scotland’s first offshore wind turbine testing facility will be located at Clydeport’s Hunterston site in North Ayrshire [91]. The site will be onshore but for the exclusive use of testing offshore wind turbines [91], and will be an extension of the Centre of Engineering Excellence for Renewable Energy (CEERE) based in Glasgow [91].
**European Offshore Wind Deployment Centre**

*Location:* Scotland, Aberdeen  
*Capacity:* 100 MW [92]  
*Status:* Consent approved 2013 [92]

The proposed EOWDC is an innovative offshore wind turbine deployment facility proposed off the Aberdeenshire coast, the project is part-funded by the European Union [92].

The vision of this project is to test new designs, prove existing products and receive independent validation and accreditation prior to commercial deployment [92].

**Deep Water Offshore Wind Test Site**

*Location:* USA, Maine, Mohegan Island  
*Capacity:* 25 MW [93]  
*Status:* Request for proposals opened 2010 [93]

The University of Maine Deep Water Offshore Wind Test Site offers waters depths of 300 feet (≈ 90m) for the installation of offshore wind turbines, including floating technologies [93].
3.6.2 WAVE

**EMEC Billia Croo Test Site**

*Location:* Scotland, Orkney  
*Capacity:* Approximately 2.2MW per berth ~ 11MW [94]  
*Status:* Operational 2003 [82]

The European Marine Energy Centre (EMEC) in Orkney is a grid connected test facility for full scale wave & tidal technologies [95]. The Billia Croo Test Site is the dedicated wave energy test site at EMEC [82]. The site consists of 5 berths, approximately 2 km off shore in water depths of up to 70m [82].

Currently in construction is a sixth birth which will be used for shallow water devices [84].

**EMEC Scapa Flow Test Site**

*Location:* Scotland, Orkney  
*Capacity:* Not Grid Connected  
*Status:* Operational 2012 [96]

The EMEC Centre in Orkney also has a scale testing facility for undertaking sea trials of wave energy technologies. The site has pre-existing (pre laid moorings) for developer use, and a designated area for marine operation rehearsal [96].

The site consists of 5 berths, in water depths of up to 25m [96].

**BIMEP**

*Location:* Basque, Armintza  
*Capacity:* 20 MW [97]  
*Status:* Installation planned 2011[98]

The Biscay Marine Energy Platform (BIMEP) is almost identical to the Wave Hub concept. BIMEP is a grid-connected, open sea, wave energy test and demonstration facility in Spain. Located off the Basque coast, in Armintza, it is a 8km² area with water depths between 50 and 90 m. It has a capacity of 20MW consisting of four 5MW berths [97].

Installation work was planned to start in summer 2011 [98].
Atlantic Marine Energy Test Site (AMETS)

Location: Ireland, County Mayo
Capacity: 10MW [99]
Status: Operational by 2013/14 [99]

The grid connected site is located off Annagh Head, west of Belmullet in County Mayo, Ireland [99].

The site has been developed for the testing of full scale devices, and offers two 5MW berths; one at 50m water depth and the other at 100m water depth [99].

Galway Bay Test Site

Location: Ireland, Galway bay
Capacity: Not grid Connected [100]
Status: Operational 2006 [101]

Galway Bay Test Site is used for scaled prototypes of wave energy devices (suitable for testing of 1/4 devices) [100]. The Test Site is situated on the North side of Galway Bay, off the coasts of Spiddal [100]. The site is 37 Hectares in area, with a mean water depth of 23m [100].

Wavebob Ltd was the first company to use the Galway Bay Test Site; deploying a prototype WEC device at the site in 2006 [101].

Aguçadoura Wave Farm

Location: Portugal
Capacity: 2.25 MW [102]
Status: Operational 2008 [102]

The Aguçadoura Wave Farm was the world's first attempt at a commercial wave farm. It was located 5 km offshore the Aguçadoura coast in Portugal [102]. The farm was designed to use three Pelamis wave energy converters, with an installed capacity of 2.25MW (3 x 750kW) [102]. The farm was operational in 2008, and was shut late around 2008/9 [102].
Pilot Zone (Portugal - planned first deployments 2011 - 2012)

Location: Portugal, North of Lisbon
Capacity: 250 MW [103]
Status: expected operation 2012 [103]

The pilot zone consists of a tidal area of 320 Km², and varying water depths between 30-90m [103]. The site will use a feed in tariff system to attract developers to the site, this system will be delivered in three categories:

- Demonstration; Up to 4MW/technology or 20MW national. Tariff approximately: 25-26 Euro cents/kWh [103]
- Pre-Commercial; Up to 20MW/technology or 100MW national. Tariff approximately: 16-21 Euro cents/kWh [103]
- Commercial; beyond 20MW/technology. Tariff approximately: 10-16 Euro cents/kWh up to 100MW national or 300MW global [103]

The site is expecting to see its first deployments in 2011 [103].
3.6.3 TIDAL

**EMEC fall of Warness test site**

*Location:* Scotland, Orkney  
*Capacity:* Approximately 5MW per berth ~ 40MW [94]  
*Status:* Operational 2006 [53]

European Marine Energy Centre (EMEC), fall of Warness site is a grid connected tidal test site consisting of 8 test berths over an area of 8km², and water depths ranging from 12-50m [87]. The site has tidal currents of up to 4 m/s (7.8 knots) [87].

**EMEC Shapinsay Sound Test Site**

*Location:* Scotland, Orkney  
*Capacity:* Not Grid Connected [96]  
*Status:* Operational 2011 [53]

The EMEC Centre in Orkney also has a scale testing facility for undertaking sea trials of tidal energy technologies. The site consists of 5 berths, in water depths of up to 25m, with tidal currents of 2m/sec (3.9 knots) [96].

**Bay of Fundy**

*Location:* Canada, Bay of Fundy  
*Capacity:* Approximately 1MW per berth ~ 4MW [104]  
*Status:* Operational 2009 [105]

The site is located in the Minas Passage area of the Bay of Fundy and consists of 4 berths with a water depth up to 45 meters at low tide. The site has tidal currents of up to 5 m/s [106].

Four developers have been selected for demonstration at the site: Open Hydro, Marine Current Turbines, Alstom and Atlantis Resource Corporation [106].

Open Hydro had previously deployed at the location of the site in 2009 [105].
Alderney Test Site

Location: England, Channel Islands, Alderney
Capacity: Regional area 3GW [107]
Status: Installation 2012-2016 [108]

Alderney Renewable Energy (ARE) was founded in 2004, the company was granted an exclusive licence to commercially develop the area around Alderney (north of the Channel Islands) [109].

Open Hydro and ARE intend to develop a 285 MW tidal park at the site [110], initially installing a small array of 10 turbines, installation is expected 2012-2016 [108].
3.6.4 SOUTH WEST

The South west of England has a variety of testing sites and facilities aimed at developing MRE technologies. The majority of testing facilities in the south west are aimed at the development of wave energy technologies, but can be applied to all MRE technologies.

South West Test Sites

Wave Hub

Technology Type: Wave Energy
Location: Hayle, Cornwall [83]
Capacity: 20 - 50 MW [86]
Status: Operational 2010 [111]

Wave Hub is a grid-connected offshore facility for array testing of pre-commercial wave energy converters (WEC’s), and is the world’s largest wave energy test site [112]. Wave Hub is located 16km of the coast of Hayle in Cornwall, covers a total surface area of 8km² and has a total power capacity of 20MW consisting of four births, each rated up to a maximum of 5MW [86].

![Wave Hub schematic](image)

Figure 3-30 schematic of Wave Hub facility [86]

The power infrastructure located at wave hub has been future proofed and has the capacity to be upgraded in the future to 50MW [86].
Wave Hub

Technology Type: Floating Wind  
Location: Hayle, Cornwall [83]  
Capacity: 6MW [113]  
Status: Consenting [113]

At present Wave Hub is only set up for the commercialisation of WEC, however in the near future the infrastructure located at wave hub could be used to support the development of floating wind technologies. In 2012 the ETI announced they were considering using Wave Hub as an implementation location for their ‘offshore wind floating system demonstration project’ [75].

The aim of the project is to accelerate floating wind technology development; the project will see the deployment of a single floating wind turbine, in a location of high wind speeds (10m/s +) and in waters depths of 60-100m. The project will require the turbine to be deployed for a two year period, with the potential to be extended by an additional 8 years [114].

Falmouth Bay Test Site (Fab Test)

Technology Type: Wave Energy  
Location: Falmouth Bay, Cornwall [84]  
Capacity: Not grid connected  
Status: Operational 2012 [84]

Fab Test is proof of concept open sea test facility designed to aid the development of WEC’s prior to full operational deployment at a commercial or pre commercial generating site [84].
Fab Test is a designated testing site located in Falmouth Bay in Cornwall, consisting of water depths ranging from 20-50m and has no less than three different geological seabed conditions; rock, gravel and sand [84].

**Lynmouth Tidal Test Site (LTT)**

*Technology Type:* Tidal Energy  
*Location:* Foreland Point, Devon [6]  
*Capacity:* Not grid connected – Proposed project 1.2MW [115]  
*Status:* Lease Agreed 2012 [115]

LTT is a proposed proof of concept open sea demonstration test facility designed to aid the development of tidal energy devices prior to full operational deployment at a commercial or pre commercial generating site.

The site is located off foreland point on the North Devon coast and consists of water depths of 18-20m and has a peak current flow of 2.5m/s (5knots) [6].

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**Figure 3-31 Map indicating location of Falmouth bay test site [84]**
South West Test Facilities

In addition to the test sits of the south west there is also a range of testing facilities aimed at accelerating the development of MRE technologies.

The Coastal Ocean and Sediment Transport (COAST) laboratory

Technology Type: Wave Energy
Location: Plymouth, Devon [6]

The COAST laboratory is a wave tank testing facility, designed to aid developers at prototype stage of technology development and would be suitable for testing scaled model designs of WEC devices [6].

COAST is novel in its ability to providing model testing under combined wave, current and wind loading, including sediment dynamics and tidal effects, and can operate in water depths of up to 3m with the ability to generate deep and shallow water waves [6]. Developer and customer use of the facility is supported by a dedicated technical team compromising of both academic and commercial skills [6].

The facility is based within the Marine Building at The University of Plymouth, Devon and was officially opened in October 2012 [6].

Figure 3-32 The COAST laboratory [6]

The facility consists of two main testing basins;

The Ocean Wave Basin (designed to recreate wave conditions offshore) and The Coastal Basin (designed to recreate wave conditions at the shore line) [6].
South West Mooring Test Facility (SWMTF)

**Technology Type:** Wave, Energy and Floating Wind  
**Location:** Falmouth, Cornwall [6]

The South West Mooring Test Facility (SWMTF) is a unique mooring load and response test facility designed to investigate mooring/umbilical behaviour & subsea components for marine energy converters and to develop suitable subsea monitoring systems [6].

The SWMTF has been constructed, launched and operated by the University of Exeter, and is located in Falmouth bay, Cornwall.

![Image of SWMTF Buoy](image.jpg)

Figure 3-33 Installation of the SWMTF Buoy. [Image courtesy of Dr Lars Johanning, The University of Exeter]

The facility collects responses loads and environmental data necessary for the analysis of dynamic response of floating marine structures, and has been designed to investigate mooring/umbilical behaviour, subsea components and to develop suitable subsea monitoring systems [6].
Dynamic Marine Component Test Facility (DMaC)

Technology Type:  Wave, Energy and Floating Wind
Location:  Falmouth, Cornwall [6].

The Dynamic Marine Component Test Facility (DMaC) is designed to support research into the reliability of marine renewable energy devices, allowing developers to identify potential failure mechanism [6].

![Figure 3-34 DMaC Test Facility [6]](image)

The DMaC test rig recreates the forces and motions acting on MRE device components in an offshore environment. The rig consists of a linear hydraulic cylinder at one end that can be used to recreate tension and compression force and at the other end a moving headstock with three degrees of freedom (pitch, roll and yaw) used to recreate bending and torsion forces [6].

The headstock aims to replicate the motion of a floating body (e.g. the floating WEC device) while the hydraulic cylinder is replicating the anchor attachment [6].

The application of such component reliability testing can reveal design weaknesses prior to deployment, support development of the sector and ultimately reduce risk and cost [6].
3.7 MRE SUPPORT ASSOCIATIONS

3.7.1 MRE SUPPORT ASSOCIATIONS IN THE UK

Marine Energy Program
The UK Marine Energy Program has been set up by the UK government to focus on enhancing the country’s ability to develop and deploy wave & tidal technologies at a commercial scale [116]. The program centres on a series of government policies (led by DECC) as well as provide a direct link between government and MRE sector stakeholders [116].

The Marine Energy Program is governed by The Marine Energy Programme board (the board includes key stakeholders from across the marine energy sectors) which play a central role in advising ministers what actions the Marine Energy Program should address to advance the MRE industry [116]. The Marine Energy Program is also responsible for the designation and vision of the UK Marine Energy Parks [116].

Marine Energy Parks (MEP)
The vision of the marine energy parks is to bring together all marine energy expertise under one umbrella in a designated geographical area [116].

The park environment encourages clustering activity and collaborative partnerships; bringing together differing disciplines, facilities and experts to facilitate the commercialisation of the marine energy sector [116].

Currently the UK has seen the designation of two Marine Energy Parks:

1. The South West Marine Energy Park
In January 2012 The South West Marine Energy Park was named as the first UK Marine Energy Park in the UK [117].

Greg Barker, MP (Minister of State for Climate Change) was quoted to say “The South West Marine Energy Park will stretch from Bristol through to Cornwall and as far as the Isles of Scilly. It will create a collaborative partnership in the region between national and local government” [117].
2. The Pentland Firth and Orkney Waters Marine Energy Park

In July 2012 The Pentland Firth and Orkney Waters Marine Energy Park was named as the second UK Marine Energy Park [118].

Fergus Ewing, MSP (Minister for Energy) was quoted to say "The Marine Energy Park designation of the Pentland Firth and Orkney Waters region will further enhance Scotland’s leading position in marine renewables" [119].

**Offshore Renewable Energy Catapult (OREC)**

The OREC centre is a ‘centre of excellence’ designed to assist in developing the offshore energy markets and technologies [120]. OREC aims to become the ‘go to’ institute for the delivery of interconnected technology innovation services [121].

OREC is one of the Technology Strategy Boards (TSB) innovation centers [122], and will build strong links with other MRE ‘centres of excellence’ including the European Marine Energy Centre (EMEC), Wave Hub, and the UK’s Marine Energy Parks [123].

In February 2012 it was announced that OREC would be located in Glasgow, with an additional operational centre in the North East of England [123]. The OREC is expected to officially open for business in summer 2012 [123].

**RenewableUK**

RenewableUK is the UK’s leading not for profit renewable energy trade association, which supports the development of wind (on and offshore) and marine (wave & tidal) energy in the UK [124].

The association facilitates many industry reports [125], national conferences and annual exhibitions [126].

**SuperGen UK Centre for Marine Energy Research (UKCMER).**

The SuperGen UKMER is a centre of research for MRE technologies, it has been running since 2003 [127].

The SuperGen UKMER is a collaboration of research work from 15 of the most prestigious universities in the UK [127]. The centre facilitates and enables assess to knowledge though the availability of reports, publications and a general reading lists on MRE topics [127].
3.7.2 SUPPORTING ASSOCIATIONS IN THE SOUTH WEST

The south west has a strong MRE support sector and comprises several academic institutes, research facilities/initiatives and industry support bodies [6]. This support provides the sector with access to research facilities and expertise as well as supporting local supply chain companies and promoting the south west as a ‘centre of excellence’ for MRE development and deployment.

Academic Institutes

The University of Exeter

The University of Exeter has played a significant role in the development of MRE in the south west, as well as developing several MRE testing facilities, notable; The SWMTF, The DMaC and Fab Test [6].

The University has campuses both in Devon and Cornwall [128] and has provided services and expertise to several MRE developers working in the south west, notable; Fred Olsen [129] and Ocean Power Technologies (OPT) [130].

The University of Exeter has also played a key role in south west based MRE research initiatives and projects, notable; PRIMaRE & Marine Energy in Far Peripheral and Island Communities (MERiFIC) [6].

The University of Plymouth

The University of Plymouth has played a significant supporting role the development of MRE in the south west, through the development of The COAST laboratory and its work with the PRIMaRE initiative [6].

The university has a campus in Plymouth, Devon and has provided services and expertise to WEC developers, notable; OWEL and IT Power [131].

The University of Bristol

The University of Bristol is home to the ‘Advanced composite centre for Innovation and Science’ (ACCIS) [132]. The vision of the ACCIS is to “be a world leading centre for composites research and education” [132]. Much of the work carried out at the ACCIS will be directly applicable to the MRE sector, specifically; wind turbine blades, tidal turbine blades and WEC floating structures [132].
Research Initiatives

PRIMaRE
The Peninsula Research Institute for Marine Renewable Energy (PRIMaRE) is an initiative between the University of Exeter and the University of Plymouth, which has brought together a team of international researchers to accelerate the development of marine energy technology [133]. PRIMaRE is aimed at supporting business and Industry by providing;

- Access to academic MRE expertise
- A range of research activities
- Support for Wave Hub
- Creating new MRE testing facilities [134]

The Marine Energy in Far Peripheral and Island Communities (MERiFIC) project
The MERiFIC project aims to accelerate the development and adoption of marine renewable energy (MRE) across Cornwall (UK) and Finistère (France) [135]. ‘Project partners will work together to identify the specific opportunities and issues faced by peripheral and island communities in exploiting marine renewable energy resources’ [135]. A key focus of the project will be to identify and break down the ‘barriers’ to the development and deployment of marine energy schemes across the two regions [135].

Industry Support Bodies

Marine Offshore Renewables (MOR)
The Marine Offshore Renewable (MOR) Group is a member based partnership of established market-leading MRE supply chain companies delivering solutions to marine renewable projects [136]. The group is based in the south west of England and aims to promote MRE supply chain companies and encourage MRE project development in the county [136].
Regen South West (Regen SW)
Regen south west is a renewable energy trade association which supports the delivery of renewable energy projects and energy efficiency in the south west of England [137].

The association facilitates local industry reports & publications, business to business meetings and introductions, regional conferences, exhibitions and events [138].

Regen SW also produce the SWMEP prospectus [139], the Regen SW Marine energy and offshore wind supply chain directory [140] and host of the South West Green Energy Awards [141].

Cornwall Marine Network (CMN)
Cornwall marine network is an organisation dedicated to supporting the marine sector in Cornwall via initiatives that improve profitability and encourage growth through quality and innovation [142]. CMN recognise the potential economic benefit for its members in supporting and assisting the marine renewable energy sector, this has been demonstrated in the networks recent involvement and support in projects such as MERiFIC, Fab Test and the MOR group; In 2012 CMN became the hosting company of the MOR group [136].

Invest in Cornwall
Invest in Cornwall (IiC) is an inward investment company based in Cornwall, focuses on promoting Cornwall as an ideal business location and attracting investment. IiC have 6 focused industry sectors, of which renewable energy is included. IiC offer assistance to technology developers, supply chain companies and the SWMEP [143].
3.8 INFRASTRUCTURE

The development of the MRE sector in the UK will also see the investment in new infrastructure projects to support and provide services to the growing sector; many of which will be the re-development of existing UK ports and water side facilities.

3.8.1 NEW MRE INFRASTRUCTURE DEVELOPMENTS IN THE UK

**Scotland, Orkney**

The Orkney Islands in Scotland are currently developing three infrastructure projects designed to support the MRE sector; specifically wave and tidal technologies based at the EMEC centre [144]. The new infrastructure developments projects are

**Hatston Pier, Kirkwall**

The re-development of Hatston Pier will provide; new berthing facilities compromising of 385m of quayside (with 10m draft), heavy lifting capability, load out working areas, storage warehousing, and office facilities all designed to assist and support the MRE sector [144].

**Lyness Pier, Hoy**

The re-development of Lyness Pier will see the former naval base transformed into an assembly, storage and servicing centre for MRE devices. The new facilities will offer; 260m of berthing (with 10m draft), 4,000sq m of load out area, storage buildings and office facilities [144].

**Coplands Dock, Stromness**

The re-development of Coplands Dock will see the introduction of a new 100m long pier (with 6m draft) designed specifically to support vessels working in the MRE sector, and improvements to road transport infrastructure [144].
**Scotland, Fife**
Scottish Enterprise and Fife Council have invested more than £23 million in the re-development of Methil Docks to create the Energy Park Fife. The investment is hoped to secure a significant share of the UK offshore wind market [145].

**Energy Park Fife**
Energy Park Fife is a manufacturing and research facility, aimed at supporting the MRE sector. The site is located on the east coast of Scotland and encompasses; a manufacturing faculty (54 Ha), Dock facilities and a business park [146].

Samsung Heavy Industries have announced plans to test a 7MW offshore wind turbine on the site which will lead to the development a manufacturing site [146].

The site also has the potential to develop an Operations and Maintenance facility to service nearby wind farms [146].
**England, Hull**

Siemens, one of the world’s leading turbine manufactures has chosen Hull as their preferred location to develop their new offshore wind turbine manufacturing and export facility; the project is called Green Port Hull and has the potential to be the single biggest influence on Hull’s economy for generations [148].

**Green Port Hull**

Green Port Hull will involve the regeneration of Alexandra Dock, an existing port complex that is directly adjacent to a natural deep-water channel [148]. The re-development will encompasses; a factory for the production of wind turbine equipment, storage areas & buildings offices facilities, a helipad and an additional 600m of berthing [148].

![Green Port Hull (artist impression)](image)

In keeping with the ports green image, plans for the site also include the erection of a permanent wind turbine, which will supply electric for the operation of the site [148].
**England, Humber Estuary**

Able UK has unveiled plans to construct a £400 million centre for renewable energy on the bank of the river Humber. This site is primarily designed to support the offshore wind sector [150].

**Able Marine Energy Park**

The proposed Able Marine Energy Park will see the development of a new wind turbine manufacturing, assembly and testing facility. The re-development will include; a new quay offering an additional 1630m of berthing, manufacturing buildings, assembly buildings, extensive layout areas, Storage buildings and office facilities [150]

![Figure 3-37 Able Marine Energy Park (artist impression)](image-url)
3.8.2 NEW MRE INFRASTRUCTURE DEVELOPMENTS IN THE SOUTH WEST

**England, Hayle**

The £15 million [152] ‘Masterplan’ regeneration of Hayle harbor in Cornwall, will see a series of major infrastructure upgrades to the existing facilities, and will include the creation of a new marine renewables business park [153].

**The Hayle Marine Renewables Business Park**

The Hayle Marine Renewables Business Park is an operation and maintenance facility, primarily aimed at the wave energy sector. The site plans to act as the O&M base for technology developers who’s’ devices are deployed at the wave hub site [154].

![Hayle Harbour regeneration (artist impression)](image)

Figure 3-38 Hayle Harbour regeneration (artist impression) [153]

The business park will offer office and storage facilities for MRE developers and will also provide offices to Wave Hub Ltd; allowing device developers and testing site operators be in close proximity of each other [154].
4. METHODOLOGY

The methodology and flow of the overall dissertation can be seen below in Figure 4-1.

- **Introduction**: An introduction to the topic of the dissertation
- **Aim & Objective**: An outline of the overall aims and objectives of the dissertation
- **Literature & Critical review**: A comprehensive and informative report style guide to the 8 key areas of the sector; state of sector, business opportunities, regulation & policy, resource & current activity, test sites, support associations and infrastructure.
- **Methodology**: An explanation of the methodology used for the overall dissertation.
- **Application & Case Study**: Application of knowledge and creation of “diversification model” and “supply chain questionnaire”
- **Results**: Results of the “supply chain questionnaire”
- **Discussion**: Discussion of the overall finding of the dissertation.
- **Conclusion**: Conclusion in respect to the original aims and objectives of the dissertation.

Figure 4-1 Dissertation methodology
The two key unique research strands of the dissertation can be seen in below in chapter 4.1 and 4.2.

4.1 DIVERSIFICATION MODEL

The “diversification model” (seen in chapter 5.2) was created to assist potential supply chain companies in the decision making process of diversifying their business into the MRE sector.

The model is made of 7 steps, steps 1-6 are research steps, while step 7 is the concluding decisions maker, all 7 steps can be seen below

1. **Understanding the MRE sector**: Gaining a broad understanding of the sector, state of sector, business opportunities, regulation & policy, resource & current activity, test sites, support associations and infrastructure.

2. **Understanding skills and services required**: Gaining a broad understanding of the skills and service required by the sector now and in the future.

3. **Identifying locations of MRE activity**: Gaining a broad understanding of the location of current MRE activity and predicted location of future activity; key indicator for location of MRE activity will be resource location.

4. **Assessing transferable assets**: Having gaining a broad understanding of the skills and service required by the sector now and in the future, compare this with current business activities, where duplication is found transferable assets are likely to be present.

5. **Identifying target market**: With both transferable assets and locations identified, target markets can now be identified.

6. **Identifying competition**: Once target market has been identified, business competition existing in this discipline will need to be identified. Companies looking to diversify into the sector will need to address what “unique offer” they can bring to the sector, to set them apart from their competition.
7. **Identifying market entry support**: Once all of the above step have been undertaken the potential supply chain will be in a more informed position to make a decision on diversification.

The model informs potential supply chain companies of the requirements of the sector and how they can assess their business for possible service transfer into the sector.

The research required to undertake steps 1-4 are covered in this dissertation.

- **Step 1: Understanding the MRE sector**, can be seen in Chapter 3 of this dissertation
- **Step 2: Understanding skills and services required**, can be seen in Chapter 5.2 of this dissertation
- **Step 3: Identifying locations of MRE activity**, can be seen in Chapter 3 of this dissertation
- **Step 4: Assessing transferable assets**, can be seen in Chapter 5.2 of this dissertation.

Steps 5-7 will be specific to individual companies and will be based on the results from steps 1-4.
4.2 THE SOUTH WEST SUPPLY CHAIN QUESTIONNAIRE

In order to assist those companies thinking of diversifying into the MRE sector it was imperative to consult with both those;

a) Pioneering supply chain companies already working in the sector
b) Companies engaged in supporting existing MRE supply chain

4.2.1 CONSULTING THE SUPPLY CHAIN

Consulting with the existing MRE supply chain in the south west, allows insight into common successes and challenges.

The advice and experiences of such companies can assist “new to market” companies in avoiding common mistakes made from inexperience.

To enable consultation a database was compiled identifying supply chain businesses operating in the MRE sector based in Cornwall and Devon, a total of 39 were identified.

Each business was approached for participation in the questionnaire.

The questionnaire consisted of 17 pre-prepared questions and achieved a participation rate of 38%, equating to 15 supply chain businesses completing the questionnaire.

A copy of the supply chain company questionnaire can be seen in Appendix F

Support tools feedback form

In addition to the questionnaire the 15 supply chain businesses who participated in consultation, were also asked to complete a “support tools feedback form”.

The form consisted of 53 identified “support tools” for those companions working in the MRE sector, participants were asked to only tick those which they believed were useful.

The support tools feedback form achieved a participation rate of 80%, aquatinting to 12 of the 15 supply chain businesses completing the feedback form.

A copy of the support tools feedback form can be seen in Appendix G
4.2.1 CONSULTING SUPPORT ASSOCIATIONS

In establishing successful methods of engagement with the MRE supply chain it was also imperative to include discussion with organisations that are currently engaging and supporting MRE supply chain companies in diversification into the sector, allowing previously successes engagement methods to be identified while also understanding where engagement failed.

A database was compiled (through informal opinion poll of existing stakeholders) identifying engagement organisation relevant to the sector on a local, regional and national level, a total of five organisations were identified;

- Invest in Cornwall – County based
- Cornwall Marine Network – County based
- The Marine Offshore Renewables (MOR) group – Region based,
- Regen South West – Region based
- Renewable UK – National based.

Each of the five organisations was approached for consultation; though the use of a questionnaire. The questionnaire consisted of 10 pre-prepared questions and achieved a participation rate of 100%, aquatinting to 5 engaging organisations completing the questionnaire.

A copy of the supply chain support organisations questionnaire can be seen in Appendix H.
5. APPLICATION AND CASE STUDY

5.1 THE OPPORTUNITIES

5.1.1 COMMERCIALISATION OF MRE SECTOR

Cost of energy

In order for MRE technologies to reach commercial scale, the cost of energy (CoE), specifically the cost to generate electricity from a marine resource, must become economically competitive with traditional electricity generation methods. In 2010 Parsons Brinckerhoff produced the ‘Powering the Nation’ report, which set out electrical generation costs by differing technology types [155], this data can be seen in Table 5-1.

Table 5-1 Generation costs (2010) [155]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Minimum CoE (p/kWh)</th>
<th>Maximum CoE (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Combined Cycle Gas Turbine</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Tidal (Including Barrages)</td>
<td>16</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 5-1 clear shows the difference between traditional (nuclear) and marine (tidal) technologies can be as much as 32p/kWh; indicating significant development is needed to drive down marine energy generation cost if this is to become competitive.

The costs shown in the Parsons Brinckerhoff 2010 report did not included wave energy technologies, therefore the data was compared with Michael Pollitt’s published generation figures from 2009 [156], this data can be seen in Table 5-2.
Table 5-2 shows both tidal stream and tidal barrage cost separately, allowing a comparison to be made. The data clearly shows that the costs associated with tidal stream technologies are significantly lower than those associated with barrage technologies; this is primarily due to the extensive infrastructure needed for barrage technologies.

Table 5-2 Generation costs (2009) [156]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Minimum CoE (p/kWh)</th>
<th>Maximum CoE (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore Wind</td>
<td>4.7</td>
<td>8.9</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>6.1</td>
<td>9</td>
</tr>
<tr>
<td>Tidal Stream</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Severn Barrage</td>
<td>10.4</td>
<td>31.7</td>
</tr>
<tr>
<td>Wave</td>
<td>12</td>
<td>44</td>
</tr>
</tbody>
</table>

The generation costs shown in Tables 5-1 & 5-2 were combined to allow direct comparison of all MRE technologies with traditional electrical generation technologies; this is shown in Table 5-3 and Figure 5-1.

Table 5-3 Generation cost comparison of all MRE technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Minimum CoE (p/kWh)</th>
<th>Maximum CoE (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>CCGT</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>4.7</td>
<td>11</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>6.1</td>
<td>21</td>
</tr>
<tr>
<td>Tidal Barrage</td>
<td>10.4</td>
<td>38</td>
</tr>
<tr>
<td>Tidal Stream</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Wave</td>
<td>12</td>
<td>44</td>
</tr>
</tbody>
</table>

In the road to commercialisation MRE technologies will need to see generation cost drop to around 6-10p/kWh in order to become economically competitive with traditional generation technologies (nuclear and gas).

The data in Table 5-3 illustrates two very different scenarios, that of ‘2009/2010 best case scenario’ (minimum cost p/kWh) and ‘2009/2010 worst case scenario’ (maximum cost p/kWh).
In the best case scenario MRE technologies could be expected to generate electricity at a cost of 6-12p/kWh; within and just outside of an economically competitive rate. However in the worst case scenario MRE technologies could be expected to generate electricity at a cost of 18-44p/kWh; far beyond any hope of achieving economically competitive rate.

![Traditional and MRE generation costs](image)

**Figure 5-1 Comparison of traditional and MRE generation costs**

The cost of electrical generation from MRE technologies today cannot be confirmed but some assumptions can be made: The range of costs associated with offshore wind and tidal stream technologies is likely to be more refined (offering a smaller range of costs); this assumption is based on the significant level of technology development and considerable technology deployments seen in the last 4 years. The range of costs associated with wave technologies however is unlikely to have seen significant improvements to costs estimated in 2009; this assumption is based on the relatively limited level of technology development and deployment seen in the last 4 years.

Assumptions have been made due to an unavailable of current information on MRE generation costs; this is mostly likely due to the sensitivity of MRE developers; specifically issues surrounding securing finance and protection of intelligence property.
Cost of Energy Forecasting

As technology matures the CoE will reduce, until it eventually becomes economically competitive with existing technologies, at which point the technology will reach commercial stage.

Technologies such as wind energy have already become CoE competitive (The economic viability of offshore wind technologies is heavily reliant on the ROC subsidy; without which offshore wind is unlikely to be cost competitive), other technologies such as wave and tidal technologies will need to be forecast to predict when they are likely to become CoE competitive.

Wave Energy Forecasting

The Carbon Trust’s focus for success report, published in 2009 shows a cost of energy forecast for wave energy technologies for the period up to 2050 [157]. The forecast was created in 2009 and depicts two possible future scenarios: incremental and breakthrough, this is shown in Figure 5-2 [157].

![Figure 5-2 Wave CoE Forecast 2008-2050][157]

The incremental scenario is based on business as usual and the breakthrough scenario is based on an additional injection of £100m in the year 2011, both scenarios are compared to predicted central baseline energy costs and to an inflated high baseline energy cost; resulting in four possible commercialisation dates for wave energy technologies; these are shown in Table 5-4.
Table 5-4 predicted dates of wave energy commercialisation

<table>
<thead>
<tr>
<th>Incremental Scenario</th>
<th>High Energy Cost</th>
<th>Central Energy Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2035</td>
<td>2050 +</td>
</tr>
<tr>
<td>Breakthrough Scenario</td>
<td>2028</td>
<td>2044</td>
</tr>
</tbody>
</table>

Figure 5-2 shows that wave energy technologies are unlikely to become economically competitive until around 2030 onward in a high baseline CoE scenario, when considering a central baseline CoE economic competition cannot be expected until 2044 and beyond.

In 2011 DECC published a review of the generation costs and deployment potential of renewable electricity technologies in the UK [158]. The DECC CoE figures for wave energy in the period 2020-2030 differed significantly for the previous 2009 Carbon Trust data. The new DECC CoE data for wave energy can be seen in Table 5-5, the data is shown in p/kWh

Table 5-5 wave energy generation costs 2020-2030 [158]

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>20.8</td>
<td>16.8</td>
<td>13.0</td>
</tr>
<tr>
<td>Medium</td>
<td>23.7</td>
<td>19.1</td>
<td>14.7</td>
</tr>
<tr>
<td>High</td>
<td>26.6</td>
<td>21.4</td>
<td>16.3</td>
</tr>
</tbody>
</table>

Tidal Energy Forecasting

The 2011 DECC review of the generation costs and deployment potential of renewable electricity technologies in the UK [158] also included CoE figures for deep tidal stream energy in the period 2020-2030. The DECC CoE data for deep tidal stream can be seen in Table 5-6, the data is shown in p/kWh

Table 5-6 deep tidal stream energy generation costs 2020-2030 [158]

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>16.2</td>
<td>16.3</td>
<td>12.1</td>
</tr>
<tr>
<td>Medium</td>
<td>19.0</td>
<td>19.1</td>
<td>14.0</td>
</tr>
<tr>
<td>High</td>
<td>22.1</td>
<td>22.1</td>
<td>16.1</td>
</tr>
</tbody>
</table>
It was not possible to obtain any other CoE forecasting information for tidal energy technologies, therefore the following assumptions were used to determine CoE data for tidal stream technologies for the period 2009 – 2050.

**Assumptions made when populating Table 5-7**

- Figures shown in blue were taken from the 2009 Carbon Trust Report: Focus for Success; High CoE based on CCGT generation starting at 5.4p/kWh in 2010 rising to 7.1p/kWh in 2030; Central CoE based on CCGT generation starting at 3.92p/kWh in 2008 and rising to 4.2p/kWh in 2030 (extrapolated to 4.48p/kWh in 2050) [157].
- Wave energy figures shown in red were estimated from the "wave-incremental learning" curve shown in Figure 5-2 [157]
- Figures shown in purple and in brackets were taken from the DECC review of the generation costs and deployment potential of renewable electricity technologies in the UK [158]
- Initial tidal stream data point was taken to be: 13.5p/kWh in 2009; this was estimated using the following method; taking the wave energy figure shown in 2009 in Table 5-3 to be 33p/kWh, which equates to 75% of the maximum CoE value 44p/kWh seen in Table 5-3, therefore this ratio was applied to the tidal data e.g. maximum tidal stream CoE in 2009 was 18p/kWh, 75% of which would equate to 13.5p/kWh.
- Figures shown in green are CoE estimates for Tidal Stream data; values decrease over time in line with wave energy CoE decline in the same period. It is unlikely that both technologies CoE’s would reduce at the same rate, however no other data could be sourced. Details of percentage decrease used can be seen in Table 5-8.
Table 5-7 forecasting data for CoE for tidal stream technologies

<table>
<thead>
<tr>
<th>Year</th>
<th>Central CoE (p/kWh)</th>
<th>High CoE (p/kWh)</th>
<th>Wave CoE (p/kWh)</th>
<th>Tide CoE (p/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>3.92</td>
<td>37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>5.4</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>14 (23.7)</td>
<td></td>
<td>5.7 (19.0)</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>(19.1)</td>
<td></td>
<td>(19.1)</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>4.2</td>
<td>7.1</td>
<td>9 (14.7)</td>
<td>3.6 (14.0)</td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>2050</td>
<td>4.48</td>
<td></td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5-8 CoE decline rate for tidal technologies

<table>
<thead>
<tr>
<th>Period</th>
<th>Wave CoE at beginning of period</th>
<th>Wave CoE at end of period</th>
<th>Percentage decrease over period</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td>33</td>
<td>29</td>
<td>12%</td>
</tr>
<tr>
<td>2010-2020</td>
<td>29</td>
<td>14</td>
<td>52%</td>
</tr>
<tr>
<td>2020-2030</td>
<td>14</td>
<td>9</td>
<td>36%</td>
</tr>
<tr>
<td>2030-2040</td>
<td>9</td>
<td>6</td>
<td>33%</td>
</tr>
<tr>
<td>2040-2050</td>
<td>6</td>
<td>5</td>
<td>17%</td>
</tr>
</tbody>
</table>

Figure 5-3 shows an estimated CoE forecast for tidal technologies up to 2040, and was created using the data generated in table 3-7 (please note 2011 data was not used in Figure 5-3).
Figure 5-3 Tidal CoE Forecast 2008-2050

Figure 5-3 estimates that tidal energy technologies are could become economically competitive around 2020 onward in a high baseline CoE scenario, when considering a central baseline CoE economic competition cannot be expected until 2025 and beyond.

When considering the 2011 data [158]; the estimated dates of achieving economic competition of both wave and tidal energy have been predicted using linear extrapolation, this can be seen in Figure 5-4.
The linear extrapolation of the tidal date is skewed due to the limited data points; the tidal data is more likely to follow a path similar to the wave date, therefore both technologies are unlikely to achieve competitive CoE’s until around 2040.

Figure 5-4 Wave & Tidal stream CoE forecast
**Technology development**

In the road to commercialisation MRE technology will need to evolve and develop through many stages, as the sector moves towards delivering commercially viable and mass produced products (devices or turbines).

This evolutionary development process taken by MRE technologies has been defined by the SWMEP as the ‘Technology Development Pathway’ and is set out in four key stages [6], which can be seen in Table 5-9.

<table>
<thead>
<tr>
<th>Key stage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCEPT</td>
<td>Concept design/engineering, Technology assessment, Intellectual property, Computer based modelling, Economic modelling</td>
</tr>
<tr>
<td>PROTOTYPE</td>
<td>Part scale &amp; full scale prototypes, CFD modelling and performance modelling, Sea trials and device deployment, Hydrodynamic testing, Electrical systems &amp; component design, Prototype verification</td>
</tr>
<tr>
<td>DEMONSTRATION</td>
<td>Full scale and array testing, Environmental impact assessment, Installation and foundation design and testing, Engineering design, Reliability &amp; performance analysis</td>
</tr>
<tr>
<td>COMMERCIAL</td>
<td>Design for manufacture, Cost reduction, Warranty &amp; certification</td>
</tr>
</tbody>
</table>

Each technology type will begin at concept stage and progress through each stage of the develop pathway until achieving commercial stage.
Currently all four MRE technology types are operating at different levels within the pathway, this is shown in Table 5-10.

Table 5-10 Technology type development level

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Concept</th>
<th>Prototype</th>
<th>Demonstration</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore Wind</td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Floating Wind</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Wave</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tidal</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td></td>
</tr>
</tbody>
</table>

*Offshore Wind* technology is the only group to be currently operating at Commercial stage; although there is still some activity at Demonstration stage; based around reliability.

*Floating Wind* technology is currently operating at four stages of the pathway. The turbine section of the technology is proven and therefore operates at Commercial & Demonstration stage (exactly as offshore wind), the float & mooring section of the technology however is very immature in development and operates at Concept & Prototype stage.

*Wave* technologies are the most immature of all the MRE technologies and are mainly operating at Concept & Prototype stage.

*Tidal* technologies are moving more rapidly towards commercialisation than wave technologies and are currently operating at Prototype & Demonstration stage.
Technology Life Cycle

The full life cycle process of MRE technologies is shown in Figure 5-5 and will encompass all stages of the ‘Technology Development Pathway’ and beyond.

![Figure 5-5 MRE Technology Life Path](image)

Definition of deployment, intervention, recovery and decommissioning life path stages can be seen in Table 5-11; for definition of concept, prototype, demonstration and commercial life path stages can be seen in the ‘Technology Development in’ Table 5-9.
<table>
<thead>
<tr>
<th>Life Path Stage</th>
<th>Definition</th>
</tr>
</thead>
</table>
| **Deployment** | Deployment and installation of moorings and subsea foundations  
Transport of technology to deployment site  
Deployment and installation of technology  
Connection to moorings and subsea foundations  
Connection to subsea electrical network infrastructure |
| **Intervention** | Performance of in-situ maintenance requirements  
Performance of in-situ repair requirements  
Performance of in-situ equipment upgrades |
| **Recovery** | Disconnection from subsea electrical network infrastructure  
Disconnection from moorings and subsea foundations  
Full recovery of technology (or part of technology e.g. turbine)  
Swap out of technologies (old recovered/new installed)  
Transport of technology to shore  
Technology redeployed |
| **Decommissioning** | Disconnection from subsea electrical network infrastructure  
Disconnection from moorings and subsea foundations  
Full recovery of technology  
Full recovery of moorings and subsea foundations  
Transport of technology, mooring & foundations to shore  
Subsea deployment site returned to original state |
Additional requirements of decommissioning

The planning and processes used in decommissioning will need to be submitted when applying for initial deployment consent; this is usually a requirement of the EIA.

The ‘return seabed to original state’ requirements will be determined by the Crown Estate (through the seabed leasing process).

Common ‘return seabed to original state’ require full recovery of all moorings, anchors and foundations.

In some cases it may not be environmentally viable to fully remove foundations; therefore any sections of the foundation buried within the seabed is likely to be left in place; as removal would create a greater environmental impact, any section of the foundation protruding from the seabed is likely to be required to be removed.

It is possible that after 20-25 years (life period of a MRE technology) some anchors, foundations and other man made subsea structures will have become artificial reefs for sea wildlife, at which point there may be an environmental case for such structure not to be recovered.

The exact decommissioning requirements stipulated by the Crown Estate could have a significant impact on decommissioning costs, possible cost impacts of decommissioning requirements are shown in table 3-12.

Table 5-12 Decommissioning Cost

<table>
<thead>
<tr>
<th>Cost</th>
<th>Original seabed attachment method</th>
<th>Crown Estate requirements</th>
<th>Equipment needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Moorings</td>
<td>Full recovery of moorings</td>
<td>Small workboat</td>
</tr>
<tr>
<td></td>
<td>Gravity Based Anchor (GBA)</td>
<td>Full recovery of anchors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anchors</td>
<td>No recovery of GBA (left as artificial reef)</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>Foundations</td>
<td>Removal of protruding foundation sections</td>
<td>Subsea cutting equipment &amp; ROV</td>
</tr>
<tr>
<td>High</td>
<td>Gravity Based Anchor (GBA)</td>
<td>Full recovery of GBA</td>
<td>Heavy lift vessel</td>
</tr>
</tbody>
</table>
5.1.2 TECHNOLOGY DEVELOPMENT

Design convergence
An indicator that a technology type is moving closer to achieving commercial stage is when differing technology designs begin to converge to create a standardised design. Recognising when a technology is converging can also assist in identifying winning designs, or more specifically which design and develops to back.

Offshore Wind Energy Sector
The offshore wind energy sector has already seen design convergence in the form of the standardised ‘3 bladed’ wind turbine design; applicable to onshore, offshore and floating wind technologies.

Floating Wind Energy Sector
The wind turbines used in the floating wind energy sector are generally proven standardised technology; however the ‘Float & Mooring’ section of a floating wind turbine is still in development.

Currently there are four main types of ‘Float & mooring’ design in the sector, namely: Tri-Floater, Barge, Spar and Mono-Hull [159]. An illustration of the four different float types can be seen in Figure 5-6.

![Figure 5-6 Float & Mooring types [159]](image)
Table 5-13 shows a list of current floating wind technology developers; clearly indicating that at present there are no common trends in ‘Float & Mooring’ design and that very few developers (globally) are pursuing floating wind technologies.

Table 5-13 Floating wind developers

<table>
<thead>
<tr>
<th>Developer</th>
<th>Country</th>
<th>Device Name</th>
<th>Turbine</th>
<th>Float</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technip &amp; Nenuphar</td>
<td>France</td>
<td>Vertiwind</td>
<td>Vertical Axis</td>
<td>Tri-Floater</td>
</tr>
<tr>
<td>Statoil</td>
<td>Norway</td>
<td>Hywind</td>
<td>Horizontal Axis</td>
<td>Spar</td>
</tr>
<tr>
<td>Blue H Technology BV</td>
<td>UK &amp; Holland</td>
<td>Blue - H</td>
<td>Horizontal Axis</td>
<td>Mono-Hull</td>
</tr>
<tr>
<td>Wind Hunter Corporation</td>
<td>USA</td>
<td>Wind Hunter</td>
<td>Multi Horizontal Axis</td>
<td>Barge</td>
</tr>
<tr>
<td>Vestas &amp; Wind Plus</td>
<td>Denmark &amp; USA</td>
<td>V80 Windfloat</td>
<td>Horizontal Axis</td>
<td>Tri-Floater</td>
</tr>
<tr>
<td>Windsea AS</td>
<td>Norway</td>
<td>Windsea</td>
<td>3 x Horizontal Axis</td>
<td>Tri-Floater</td>
</tr>
<tr>
<td>Sway AS</td>
<td>Norway</td>
<td>SWAY</td>
<td>Horizontal Axis</td>
<td>Spar</td>
</tr>
<tr>
<td>Floating Power Plant</td>
<td>Denmark</td>
<td>Poseidon</td>
<td>Multi Horizontal Axis &amp; WEC</td>
<td>Barge</td>
</tr>
<tr>
<td>Floating Wind Lens</td>
<td>Japan</td>
<td>Wind Lens</td>
<td>Venturi</td>
<td>Barge</td>
</tr>
<tr>
<td>Hexicon</td>
<td>Sweden</td>
<td>Hexicon Platform</td>
<td>7 x Horizontal Axis</td>
<td>Mono-Hull</td>
</tr>
<tr>
<td>Nautica Windpower</td>
<td>USA</td>
<td>Advanced Floating Turbine (AFT)</td>
<td>2 bladed Horizontal Axis</td>
<td>Spar</td>
</tr>
</tbody>
</table>
Wave Energy Sector

The wave energy sector has the largest variety of designs of all the MRE technologies.

Using data obtained from three databases, namely the EMEC Wave Developers Database [44], the US Department of Energy Marine and Hydrokinetic Technology Database [160] and the IT Power Marine Energy Technologies Database [161], current trends in technologies design and market size percentage can be identified, this information is shown in Table 5-14.

Table 5-14 WEC design type market share

<table>
<thead>
<tr>
<th>Device type</th>
<th>Source : EMEC</th>
<th></th>
<th>Source: US Department of Energy</th>
<th></th>
<th>Source: IT Power</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Attenuator</td>
<td>30</td>
<td>19.23%</td>
<td>29</td>
<td>17.90%</td>
<td>20</td>
<td>11.83%</td>
</tr>
<tr>
<td>Point Absorber</td>
<td>63</td>
<td>40.38%</td>
<td>66</td>
<td>40.74%</td>
<td>81</td>
<td>47.93%</td>
</tr>
<tr>
<td>Oscillating Wave</td>
<td>9</td>
<td>5.77%</td>
<td>32</td>
<td>19.75%</td>
<td>10</td>
<td>5.92%</td>
</tr>
<tr>
<td>Surge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oscillating Water</td>
<td>19</td>
<td>12.18%</td>
<td>16</td>
<td>9.88%</td>
<td>30</td>
<td>17.75%</td>
</tr>
<tr>
<td>Column</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overtopping</td>
<td>9</td>
<td>5.77%</td>
<td>8</td>
<td>4.94%</td>
<td>8</td>
<td>4.73%</td>
</tr>
<tr>
<td>Other</td>
<td>26</td>
<td>16.67%</td>
<td>11</td>
<td>6.79%</td>
<td>20</td>
<td>11.83%</td>
</tr>
<tr>
<td>Total</td>
<td>156</td>
<td>100%</td>
<td>162</td>
<td>100%</td>
<td>169</td>
<td>100%</td>
</tr>
</tbody>
</table>

It should be noted that the information contained within the databases simple categories the types of technology design currently being pursued by developers and does not take into consideration technology development levels or likelihood of commercialisation; some of the WEC technologies listed in the databases will never move beyond concept stage due to poor design and limited funding.
Table 5-15 current WEC market leading design

<table>
<thead>
<tr>
<th>Device type</th>
<th>Source: EMEC</th>
<th>Source: US Department of Energy</th>
<th>Source: IT Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position</td>
<td>Percentage</td>
<td>Position</td>
</tr>
<tr>
<td>Attenuator</td>
<td>2nd</td>
<td>19.23%</td>
<td>3rd</td>
</tr>
<tr>
<td>Point Absorber</td>
<td>1st</td>
<td>40.38%</td>
<td>1st</td>
</tr>
<tr>
<td>Oscillating Wave Surge</td>
<td></td>
<td></td>
<td>2nd</td>
</tr>
<tr>
<td>Oscillating Water Column</td>
<td>3rd</td>
<td>12.18%</td>
<td></td>
</tr>
<tr>
<td>Overtopping</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-15 shows the three most common wave technology designs in each of the databases; 2nd and 3rd market leading design positions for WEC devices are not definitive design across all databases, therefore identification of an overall position was required, the following method was used:

Each market leading design position was allocated a numeric value;

1\textsuperscript{st} position = 3  
2\textsuperscript{nd} position = 2  
3\textsuperscript{rd} position = 1.

The numeric value associated with the design position can be called the trending value.

The trending value indicates the frequency at which the design is in use in the MRE market, simplified the higher the trending value the more common the design.

The results generated from this process are shown in Table 5-16.
Table 5-16 Most common WEC designs

<table>
<thead>
<tr>
<th>Device type</th>
<th>EMEC Trending value</th>
<th>US Department of Energy Trending value</th>
<th>IT Power Trending value</th>
<th>Trending Total</th>
<th>Overall global position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attenuator</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2nd</td>
</tr>
<tr>
<td>Point Absorber</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>1st</td>
</tr>
<tr>
<td>Oscillating Wave Surge</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Oscillating Water Column</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3rd</td>
</tr>
</tbody>
</table>

1st position: Currently the most commonly pursued WEC design type globally is the **Point Absorber**, achieving 1st position in all three databases, and accounting for around 40-48% of the WEC market.

2nd position: Currently the second most commonly pursued WEC design type globally is the **Attenuator**, achieving 2nd position in one database and 3rd position in the other two databases, overall positioning it as second and accounting for around 12-19% of the WEC market.

3rd position: Currently the third most commonly pursued WEC design type globally is the **Oscillating Water Column**, achieving 2nd position in one database and 3rd position in one other database, overall positioning it as third and accounting for around 12-18% of the WEC market.
**Tidal Energy Sector**

The tidal energy sector has yet to see final convergence of a single standardised design, current trends in tidal technologies have been identified using data obtained from three databases, namely the EMEC Tidal Developers Database [58], the US Department of Energy Marine and Hydrokinetic Technology Database [160] and the IT Power Marine Energy Technologies Database [161], this information is shown in Table 5-17.

**Table 5-17 Tidal device design type market share**

<table>
<thead>
<tr>
<th>Device type</th>
<th>Source : EMEC</th>
<th>Source: US Department of Energy</th>
<th>Source: IT Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
</tr>
<tr>
<td>Horizontal Axis</td>
<td>38</td>
<td>43.18%</td>
<td>63</td>
</tr>
<tr>
<td>Vertical Axis</td>
<td>16</td>
<td>18.18%</td>
<td>32</td>
</tr>
<tr>
<td>Hydrofoil</td>
<td>4</td>
<td>4.55%</td>
<td>4</td>
</tr>
<tr>
<td>Venturi</td>
<td>8</td>
<td>9.09%</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>25.00%</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>88</td>
<td>100%</td>
<td>110</td>
</tr>
</tbody>
</table>

Table 5-18 shows the three most common tidal technology designs in each of the databases.
Table 5-18 current market leading tidal technology designs

<table>
<thead>
<tr>
<th>Device type</th>
<th>Source : EMEC</th>
<th>Source : US Department of Energy</th>
<th>Source: IT Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Position</td>
<td>Percentage</td>
<td>Position</td>
</tr>
<tr>
<td>Horizontal Axis</td>
<td>1st</td>
<td>43.18%</td>
<td>1st</td>
</tr>
<tr>
<td>Vertical Axis</td>
<td>2nd</td>
<td>18.18%</td>
<td>2nd</td>
</tr>
<tr>
<td>Hydrofoil</td>
<td>3rd</td>
<td>9.09%</td>
<td>3rd</td>
</tr>
<tr>
<td>Other</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

1st position: Currently the most commonly pursued tidal technology design type globally is the **Horizontal Axis Turbine**, achieving 1st position in all three databases, and accounting for around 43-57% of the tidal market.

2nd position: Currently the second most commonly pursued tidal technology design type globally is the **Vertical Axis Turbine**, achieving 2nd position in all three databases, and accounting for around 18-29% of the tidal market.

3rd position: (Calculated using methodology described on page 80) Currently the third most commonly pursued tidal technology design type globally is the **Hydrofoil**, achieving 3rd position in two databases, overall positioning it as third and accounting for around 3-4% of the tidal market.
**Components market**

MRE technologies are costly and complex engineering structures consisting of many component parts, the component market for MRE technologies (Specifically commercial stage technologies, where designs are standardised, and therefore component parts are standardised) is expected to be considerable, with high expectation of growth, mainly due to; an increased in technologies deployed and maintenance requirements (replacement parts) of older technologies.

**Offshore wind**

Using data obtained from the Mentor Consulting website [162], Figure 5-7 was generated to show the typical component cost breakdown of a wind turbine (based on using a REpower MM92, with 45.3m blade length and 100m tower), exact percentage figures can be seen in Table 5-19.

![Wind turbine component breakdown](data sourced from 162)
The potential economic value of each component part can then be identified, as shown in Table 5-19. Components of major, intermediate and minor economic value can then be identified, as shown in Table 5-20. It is clear from Table 5-20 that the components with greatest economic value are: towers, blades and gearboxes.

Table 5-19 Economic value of wind turbine components [data sourced from 162]

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>% of total turbine cost</th>
<th>Estimated cost Low scenario</th>
<th>Estimated cost High scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower</td>
<td>Steel or Concrete</td>
<td>26.30%</td>
<td>£149,279</td>
<td>£164,207</td>
</tr>
<tr>
<td>Rotor Blades</td>
<td>Composite</td>
<td>22.20%</td>
<td>£126,007</td>
<td>£138,608</td>
</tr>
<tr>
<td>Rotor Hub</td>
<td>Cast Iron</td>
<td>1.37%</td>
<td>£7,776</td>
<td>£8,554</td>
</tr>
<tr>
<td>Rotor bearings</td>
<td></td>
<td>1.22%</td>
<td>£6,925</td>
<td>£7,617</td>
</tr>
<tr>
<td>Main Shaft</td>
<td></td>
<td>1.91%</td>
<td>£10,841</td>
<td>£11,925</td>
</tr>
<tr>
<td>Main Frame</td>
<td></td>
<td>2.80%</td>
<td>£15,893</td>
<td>£17,482</td>
</tr>
<tr>
<td>Gearbox</td>
<td></td>
<td>12.91%</td>
<td>£73,277</td>
<td>£80,605</td>
</tr>
<tr>
<td>Generator</td>
<td></td>
<td>3.44%</td>
<td>£19,525</td>
<td>£21,478</td>
</tr>
<tr>
<td>Yaw system</td>
<td></td>
<td>1.25%</td>
<td>£7,095</td>
<td>£7,805</td>
</tr>
<tr>
<td>Pitch system</td>
<td></td>
<td>2.66%</td>
<td>£15,098</td>
<td>£16,608</td>
</tr>
<tr>
<td>Power converter</td>
<td></td>
<td>5.01%</td>
<td>£28,437</td>
<td>£31,280</td>
</tr>
<tr>
<td>Transformer</td>
<td></td>
<td>3.59%</td>
<td>£20,377</td>
<td>£22,415</td>
</tr>
<tr>
<td>Brake System</td>
<td></td>
<td>1.32%</td>
<td>£7,492</td>
<td>£8,242</td>
</tr>
<tr>
<td>Nacelle housing</td>
<td>Composite</td>
<td>1.35%</td>
<td>£7,663</td>
<td>£8,429</td>
</tr>
<tr>
<td>Cables</td>
<td></td>
<td>0.96%</td>
<td>£5,449</td>
<td>£5,994</td>
</tr>
<tr>
<td>Screws</td>
<td></td>
<td>1.04%</td>
<td>£5,903</td>
<td>£6,493</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>10.67%</td>
<td>£60,563</td>
<td>£66,619</td>
</tr>
<tr>
<td>Total Turbine</td>
<td></td>
<td>100.00%</td>
<td>£567,600</td>
<td>£624,360</td>
</tr>
</tbody>
</table>

Table 5-19 additional information

- “Other” component category consists of several components, all of which account for less than 0.96% individually [162].
- “Total Turbine” figure based on case study of an offshore wind project, total project costs of €2,000,000 - €2,200,000/MW [163], using a conversion rate of € 1 = £ 0.86 [164], this equated to around £1,720,000 - £1,892,000/MW. Using the offshore wind project cost breakdown shown in Figure 3-6, the actual cost of a single: offshore wind turbine can be estimated to be 33% (turbine & tower) of the overall project cost, which equates to £567,600 – 624,360.
### Table 5-20 Wind Turbine Component Market Size Category

<table>
<thead>
<tr>
<th>Market size</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major:</strong> where components listed offer economic value ≥ £56.7k/turbine (≥ 10% of the total turbine cost)</td>
<td>Tower, Rotor Blades &amp; Gearbox</td>
</tr>
<tr>
<td><strong>Intermediate:</strong> where components listed offer economic value ≥ £11.3k/turbine (≥ 2% of the total turbine cost)</td>
<td>Power converter, Transformer, Generator, Main Frame &amp; Pitch system</td>
</tr>
<tr>
<td><strong>Minor:</strong> where components listed offer economic value &lt; £11.3k/turbine (&lt; 2% of the total turbine cost)</td>
<td>Main Shaft, Rotor Hub, Nacelle housing, Brake System, Yaw system, Rotor bearings, Screws, Cables, Other</td>
</tr>
</tbody>
</table>
Wave

Typical component cost breakdown of a wave energy device can be seen in Figure 5-8 (This is an aggregated view; in individual cases the relative cost of elements can vary considerably dependent on design. Assembly and other generic costs are spread across components) [85].

Due to the immature nature of wave energy technologies (specifically a lack of design convergence) percentage values shown are broad averages and would vary considerable according to individual WEC design.

![Figure 5-8 WEC component breakdown](data sourced from 85)
Components of WEC have been categorised into four key component systems; these systems are not definitive and would in reality consist of a wide range of individual components. Definition of each of the four component systems can be seen in Table 5-21.

Table 5-21 Component System definition [85]

<table>
<thead>
<tr>
<th>Component System</th>
<th>Definition</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrodynamic</td>
<td>Component that moves directly under the influence of the force applied by the water</td>
<td>Turbine blades, hydrofoil or body reacting to wave motion</td>
</tr>
<tr>
<td>Reaction</td>
<td>Component keeping device in position.</td>
<td>Moorings, anchors &amp; foundations</td>
</tr>
<tr>
<td>Power take off</td>
<td>Component used to convert motion of device to electrical energy</td>
<td>Hydraulic motor, linear electric generator, gearboxes &amp; electric motors</td>
</tr>
<tr>
<td>Control</td>
<td>Component used for yawning, pitching, braking &amp; hydraulic system adjustment</td>
<td>Sensors, electrical equipment &amp; Supervisory Control and Date Acquisition (SCADA) systems.</td>
</tr>
</tbody>
</table>

The potential economic value of each component part can then be identified, as shown in Table 5-22.
<table>
<thead>
<tr>
<th>System</th>
<th>Material</th>
<th>% of total turbine cost</th>
<th>Estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrodynamic</td>
<td>Steel, Concrete or Composite</td>
<td>35%</td>
<td>£343,140</td>
</tr>
<tr>
<td>Reaction</td>
<td>Steel or Concrete</td>
<td>30%</td>
<td>£294,120</td>
</tr>
<tr>
<td>Power take off</td>
<td></td>
<td>30%</td>
<td>£294,120</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>5%</td>
<td>£49,020</td>
</tr>
<tr>
<td>Total Device</td>
<td></td>
<td>100%</td>
<td>£980,400</td>
</tr>
</tbody>
</table>

Table 5-22 shows that at present the component system with the greatest economic value in wave energy technologies is the hydrodynamic system; due to the immature nature of the sector, it is possible that this will change in future.

Table 5-22 additional information

- “Total Device” figure based on case study of a wave farm project; €9 million project cost of the installation of a three Pelamis devices [165] using a conversion rate of € 1 = £ 0.86 [164], this equated to £7,740,000. Using the wave energy project cost breakdown shown in Figure 3-8, the actual cost of a single WEC device can be estimated to be 38% (device manufacture) of the overall project cost divided by three (as three devices were deployed) which equates to £980,400.
Tidal

Typical component cost breakdown of a tidal energy device can be seen in Figure 5-9 (This is an aggregated view; in individual cases the relative cost of elements can vary considerably dependent on design. Assembly and other generic costs are spread across components) [85].

Due to the developing nature of tidal energy technologies, percentage values shown are averages.

Components of Tidal technologies have been categorised into four key component systems (each consist of a wide range of individual components), details of which can be seen in Table 5-21.

The potential economic value of each component part can then be identified, as shown in Table 5-23.
Table 5-23 Economic value of tidal technology component systems

<table>
<thead>
<tr>
<th>System</th>
<th>Material</th>
<th>% of total turbine cost</th>
<th>Estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrodynamic</td>
<td>Steel, Concrete or Composite</td>
<td>40%</td>
<td>£518,400</td>
</tr>
<tr>
<td>Reaction</td>
<td>Steel or Concrete</td>
<td>36%</td>
<td>£466,560</td>
</tr>
<tr>
<td>Power take off</td>
<td></td>
<td>19%</td>
<td>£246,240</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>5%</td>
<td>£64,800</td>
</tr>
<tr>
<td>Total Device</td>
<td></td>
<td>100%</td>
<td>£1,296,000</td>
</tr>
</tbody>
</table>

Table 5-23 shows that at present the component system with the greatest economic value in tidal technologies is the hydrodynamic system.

Table 5-23 additional information

- “Total Device” figure based on case study of a tidal turbine installation: £3.6 million project cost of the installation of a single SeaGen device [166]. Using the tidal turbine project cost breakdown shown in Figure 3-7, the actual cost of a single SeaGen device can be estimated to be 36% (device manufacture) of the overall project cost, which equates to £1,296,000.
Materials market

MRE materials
The main material currently used in the fabrication and manufacture of MRE technologies is steel, however in the future other materials such as composite and concrete may be used.

Steel
Steel is the main construction material currently used for all MRE technologies, and is generally used in offshore wind turbine towers, offshore wind turbine subsea jackets, tidal device structures (excluding turbine blades) and WEC main structural bodies. Steel is primarily used due to its relative ease of use and its versatility, which make it a low risk solution to currently developers; it is also currently the cheapest option for developers when considering large scale fabrication; however over time other materials may become more attractive to MRE technology developers.

Two significant disadvantages in the use of steel for MRE technologies are corrosion and weight.

Corrosion can be mitigated through the use of specialist coating and ‘U paints’, however steel structures at sea will always be susceptible corrosion; producing an on-going maintenance requirement. Weight of steel (7860kg/m$^3$ [167]) in comparison to materials such as composite can be very significant when considering like for like structures. The significance of the weight increase will affect the equipment needed (specifically heavy lift capacity) for fabrication, deployment and recovery of the device; producing additional costs.

Concrete
It is possible that concrete will become a favoured construction material for the MRE sector; predicted uses include manufacture of GBA anchors and WEC devices. Concrete is an attractive material of use in the MRE sector due to its inability to corrode and lighter weight (2400kg/m$^3$ [168]), when compared with steel. It is however not without its own disadvantages which included low strength.
Concrete has *low strength* when loaded in tension; therefore the material is reinforced with the use of steel to improve its tensile properties; this is known as reinforced concrete. Reinforced concrete (in a saline environment) is susceptible to *corrosion* due to the reinforcing steel embedded within the concrete.

*Composite*

Composite materials are already used in turbine blade manufacture for both wind and tidal turbines. Composite also has great potential to become the main construction material used in the wave energy sector, due to its light weight (1200kg/m³ [169]), designable strength and resistance to corrosion. It is however not without its own disadvantages which included high cost and high risk to the developer.

The *high cost* of manufacturing composite materials primarily comes from the design and manufacture of a mould; which all structure will be cast from, this is itself usually made in another composite material.

When manufacturing take place from a pre-cast moulding, additional changes to the design cannot be made; presenting technologies developers (especially relevant to emerging non-converged technologies) with a *high risk* manufacturing solution.
MRE material market opportunities

Offshore wind

The predicted steel requirement for offshore wind can be expected to grow over the next 10 years; due to the manufacture and deployment of Round 3 offshore wind farm sites. The UK is unlikely to see economic benefit from turbine manufacture (turbines are typically manufactured outside of the UK) but will have significant opportunities to supply turbine foundations (piles, jackets). Steel use in the offshore wind sector is expected to remain the same (primarily used in towers and foundations), with continued use of composite in blade manufacture.

Floating wind

As the demand for floating wind technologies is created and increases, the UK will need to position itself as a manufacture of floating foundation, if it is too sustain it's industry created on the back of traditional offshore wind turbine foundations.

The demand for floating wind turbine foundations is likely to be a gradual process where market demand for both floating and traditional foundations could exist simultaneously; however in the long term floating foundations have the potential to have a significantly larger market share than traditional foundations.

Wave and Tidal

The predicted steel requirement for the manufacture of both wave and tidal devices, intended for deployment in ‘The Pentland Firth and Orkney Waters Development’ can be seen in Figure 5-10 [85].

The data shown is based on all technologies using steel as their main fabrication material, and therefore actual figures shown may not be a true representation of future steel demand (in relation to MRE technologies); it is possible that material such as composite could take a significant ‘chuck’ of market demand in later years, 2018 and beyond (when standardise designs of technologies has been achieved).
The ‘Pentland Firth and Orkney Waters’ development is a technology dense, geographical location, where a significant volume of MRE technologies will need to be manufactured in a relatively small timescale small. Concentrated manufacture of wave & tidal technologies on this scale (in a localised geographical area) will not be seen in other parts of the UK without the addition of new wave & tidal commercial site leasing rounds thorough the Crown Estate.

Market opportunities to supply steel (or other manufacturing materials) may be short lived (until mass deployments are seen) as is shown in Figure 5-10, where; between 2013 – 2018 there is a clear increase in demand, however by 2020 (only 2 years later) demand has fallen by a staggering 79%, further decease in demand can be expected beyond 2020 unless new commercial sites or additional zones for deployment are introduced.
5.1.3 TECHNOLOGY INSTALLATION

Technology foundations

Offshore wind

Offshore wind turbines (excluding floating wind) commonly use one of four key foundation types: *Monopile* consisting of a steel pile which is driven into the seabed to achieve anchoring. *Triple* (or commonly known as Tripod) consisting of a steel framework with usually three piles which are driven into the seabed to achieve anchoring. *Jacket* consisting of a steel lattice tower structure and four piles which are driven into the seabed to achieve anchoring. *Gravity* consist of a large mass, usually constructed from either concrete or steel which uses the force of gravity to achieve anchoring, simply lying on the seabed.

Figure 5-11 Offshore wind turbine foundations (from left to right, Monopile, Triple, Jacket and Gravity) [170]
Tidal

Common foundations used for tidal energy devices are monopoles, this is primarily due to the graphical condition of the sea bed; commonly rock seabed geology is found at high velocity tidal sites, this is due to the current carrying any sediment or debris away from the site.

Rock seedbed conditions are not suitable for the use of drag embedment anchors or suction piles (a suction pile consisting of hollow pile which can be driven into sediment, creating a suction effect which achieves anchor stability) which both need sediment conditions to achieve stability. GBA anchors are also typically not suitable for tidal device foundations due to their fluid dynamic properties; GBA’s will experience a drag force when placed in a tidal current, this force will reduced the GBA’s holding capacity, therefore to stabilise holding capacity additional weight is needed (which often results in an increase in mass and surface area), which increases the drag force and compromises the GBA holding capacity [171].

Wave

Wave energy devices commonly use one of three key foundation types: GBA consisting of mass of concrete or steel, commonly weighing several hundred tonnes (a general rule when sizing a GBA for a mooring configuration is the GBA will be three times the magnitude of the load acting on the mooring line, e.g. a mooring line with a load of 150t would need a gravity base of 450t [172]). Suction Pile (or Suction Anchor) consisting of hollow pile which can be driven into sediment, creating a suction effect which achieves anchor stability. Drag Embedment consisting of a steel anchor which achieves anchor stability by embedding into seabed sediments.
Anchoring Technologies at a glance

A foundation matrix indicating what type of foundations would be suitable for use in deferring seabed conditions can be seen in Table 5-24.

Table 5-24 MRE foundation matrix

<table>
<thead>
<tr>
<th>Foundation (F) or Anchor (A)</th>
<th>Geology</th>
<th>Bathymetry</th>
<th>Current flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rock</td>
<td>Sediment</td>
<td>Uneven</td>
</tr>
<tr>
<td>Monopile (F)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Triple (F)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jacket (F)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gravity (F &amp; A)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Suction (F &amp; A)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Drag Embedment (A)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rock Bolt (A)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
**Pre installation activity**

Prior to any MRE technology installation the intended site will need to be identified and investigated. The site investigation process is shown in Figure 5-12.

Definition of site identification, resource assessment, site investigation, consenting and installation (Installation stage is the same as the deployment stage shown in the Life Cycle path, Table 5-11) can be seen in Table 5-25.
<table>
<thead>
<tr>
<th>Site Investigation Stage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site Identification</strong></td>
<td>Identification of site will be made through initial investigation of publically available information, including: resource data, shipping lanes &amp; movements, navigational charts, protected marine areas &amp; habitats and other designations of marine areas and users.</td>
</tr>
<tr>
<td><strong>Resource Assessment</strong></td>
<td>Collection and analysis of existing resource data for site Resource data (a minimum of 2 years of data is usually required by MRE developers) collection using specialist equipment, such as ADCP, wave rider buoys and met masts. Analysis and modelling of resource data with intended technology</td>
</tr>
<tr>
<td><strong>Site Investigation</strong></td>
<td>Physical site investigation work will include: Hydrographic surveys (to establish bathymetry), core sampling (to establish geology) and seabed imaging may also be needed.</td>
</tr>
<tr>
<td><strong>Consenting</strong></td>
<td>Obtaining lease for use on designated seabed area (from the Crown Estate) Obtaining licence to operate MRE technology at designated location (from the MMO) Payment of lease and licence fees. Commissioning and undertaking an EIA (usually required by MMO to obtain licence)</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Deployment and installation of moorings and subsea foundations Transport of technology to deployment site Deployment and installation of technology Connection to moorings and subsea foundations Connection to subsea electrical network infrastructure</td>
</tr>
</tbody>
</table>
**MRE installation vessels**

Vessels commonly used in the installation of MRE Technologies are Jack-up barges, crane barge, Dynamic Positioning (DP) vessels, multicats and a multitude of smaller support vessels to assist in marine operations.

Vessels used in MRE deployment and installation are in high demand, as they are also required by the oil and gas sector; the increase in competition combined with the incredible wealth of the oil and gas sector can make procurement of such vessel extremely costly.

**Offshore Wind**

Vessels commonly used in the installation of offshore wind technologies are Jack-up barges and crane barges.

*Jack-up barges* are commonly used for the installation of offshore wind turbines, as they provide a stable platform from which installation can be undertaken. An illustration of a jack-up barge installing an offshore wind turbine can be seen in Figure 5-13.

**Figure 5-13** Installation of an offshore wind turbine using a jack-up barge [173].
Crane barges (specifically heavy lift barges) are commonly used for the installation of offshore wind turbines, as they can provide the lift capacity needed of turbine installation; commonly the minimum lifting capacity required for the installation of offshore wind turbines is approximately 800 tonnes (this may increase over time as turbines become larger).

An extensive ‘Offshore Wind Vessel Database’ can be found at: www.4coffshore.com
**Tidal**

Vessels commonly used in the installation of tidal technologies are crane barges and dynamic positioning vessels.

Jack-up barges are not traditionally used in the installation of tidal technologies due to the loadings experienced in the legs of the barge, when placed in high velocity tidal flow conditions. The legs of a jack-up barge are designed for vertical loading and therefore the horizontal loading imparted by the current flow can compromise the vessel's stability. The legs of a jack-up barge are also susceptible to Vortex Induced Vibration (VIV) which can compromise structural integrity.

Vessels used to install tidal technologies are exposed to exceptionally strong currents; in order to stay on station vessel will require robust mooring system and/or dynamic positioning capability.

**Crane barges** (specifically heavy lift barges) are commonly used for the installation of tidal devices; commonly the minimum lifting capacity required for the installation of a tidal device is approximately 250 tonnes [174] (this may increase over time as turbines become larger).

**Dynamic Positioning (DP) Vessels** are the most advantageous vessel to use when installing tidal technologies, and are fast becoming the most commonly used, however they are notoriously expensive. The pay-off in high day rates is balanced by their potential ability to execute deployed more rapidly (in comparison with other vessels), which in turn reduces exposure to down time, extended charter and personal safety).
**HiFlo-4**

Recently, south west based supply chain company Mojo Maritime has designed and developed a patented unique tidal installation vessel named HiFlo-4 [175]. HiFlo-4 is a dynamic positioning vessel, capable of operating in tidal currents of up to 10 knots (5.1m/s) [175], increasing the vessels working availability, and ultimately decreasing vessel ‘down time’ and project installation cost.

Modelling carried out on the HiFlo-4 predicts a capability to install up to 50 turbines a year, equating to 70MW of installed capacity from a single vessel [175].

![HiFlo-4 CAD Image](image_url)

**Figure 5-14 CAD image of HiFlo-4 [175]**

Richard Parkinson, Mojo’s Managing Director, commented: “The key design driver for this vessel is more efficient and safer marine operations in high tidal flows: current methods are too high risk and major investors/ utilities will not entertain high risk activities on their sites.” [175].

The vessel is expected to be commercially available in summer 2015, and will be operated by Mojo Maritime [175].
Wave
At present there have only been a limited number of WEC deployment, most of which were scaled model, therefore there is little historical evidence on vessel used for the installation of full scale WEC.

Form the few WEC devices which have been deployed a variety of installation vessels have been used; Aquamarine Power installed their Oyster 2 using large jack-up vessels (which were required for subsea drilling and installation of foundation piles) as Fred Olsen installed their Bolt Lifesaver device using a multicat [176].

Multicat vessels have historically been used for the installation of WEC (scaled), primarily due to their versatile and adaptable use while incurring relatively inexpensive procurement cost.

An advantage in the WEC sector is device buoyance (seen in many WEC designs but not all), this buoyance can be an advantage when considering installation; buoyant devices can be floated and towed to deployment sites reducing the need for heavy lifting both at the quayside and offshore. There still may be a need for the use of heavy lifting capability due to the anchoring system used by the WEC.
Support vessels
Support vessels used in the MRE sector as a whole include: hydrographic survey vessel, cable laying vessel, geological investigation vessels, O&M vessels, tug boats, workboats, ribs, power boats and crew transfer vessels.

*Hydrographic Survey Vessel* used for the investigation and in establishing seabed bathymetry

*Cable Laying Vessel* used for the installation of power and communication network cabling.

*Geological investigation vessels* used for the investigation and in establishing seabed geology, including drilling vessels and obtaining seabed core samples.

*O&M Vessels* used in the operation and maintenance of MRE technologies, these vessel can be large in size if transporting, recovering and installing new components, such as turbine blades.

*Tug boats* used to assist larger installation vessels may be used to support vessel station keeping when installing.

*Workboats* used to assist installation and support vessels.

*Ribs* used to access near shore deployed technologies (such as devices deployed at FabTest)

*Power Boats* used to transport visiting guests or stakeholders to the deployment site (for technology viewing).

*Crew Transfer Vessels* used to transport maintenance personnel offshore.
MRE vessel materials

Materials used for the construction of vessels working in the MRE sector, generally consist of two materials, steel and composite.

Steel is the traditional material used in ship building and therefore most vessel working offshore will be constructed using steel, however there is one particular group of MRE vessels, where composite and aluminium materials are favoured in vessel construction.

Maintenance personnel for MRE technologies (at present this is only relevant to offshore wind technologies) are exposed to a high risk environment every time they transfer to and from offshore locations.

Traditionally crew transfer offshore has been dominate by the use of helicopters in the oil and gas sector, however the use of helicopters for crew transfer in the MRE sector is unlikely to be seen for two reasons: distance and cost.

The distance to offshore wind farms (from shore) is much closer than the distance to offshore oil platforms.

The cost of running and maintaining a crew transfer helicopter service is very expensive.

Therefore crew transfer to offshore wind farms is currently undertaken using ‘crew transfer’ vessels; which need to be fast, speed is essential to reduce the time personnel are in transit (reducing exposure to risk).

The speed element needed by crew transfer vessels required vessels to become lighter or more powerful; using composite materials or aluminium in the construction of crew transfer vessels can greatly reduce the weight of the vessel and therefore high speed personnel transits can be achieved.
A list of current crew transfer vessels and their construction material can be seen in Table 5-26.

<table>
<thead>
<tr>
<th>Material used</th>
<th>Vessel operator</th>
<th>Vessel Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Fred Olsen</td>
<td>WIC21C</td>
</tr>
<tr>
<td></td>
<td>Windcat Workboats</td>
<td>Windcat Mk1</td>
</tr>
<tr>
<td></td>
<td>Windcat Workboats</td>
<td>Windcat Mk2</td>
</tr>
<tr>
<td></td>
<td>Windcat Workboats</td>
<td>Windcat Mk3</td>
</tr>
<tr>
<td></td>
<td>Eastern Marine Services</td>
<td>Norman Forster</td>
</tr>
<tr>
<td></td>
<td>Turbine Transfers</td>
<td>Carmel Head</td>
</tr>
<tr>
<td></td>
<td>South boats Group</td>
<td>15m FRV (Fast Response Vessel)</td>
</tr>
<tr>
<td></td>
<td>South boats Group</td>
<td>16m WFSV (Wind Farm Service Vessel)</td>
</tr>
<tr>
<td>Composite</td>
<td>Windcat Workboats</td>
<td>Windspeed</td>
</tr>
<tr>
<td></td>
<td>South boats Group</td>
<td>12m RRV (Rapid Response Vessel)</td>
</tr>
<tr>
<td></td>
<td>South boats Group</td>
<td>12m Workboat</td>
</tr>
<tr>
<td></td>
<td>Kockums</td>
<td>CarboCAT23 CarboClyde</td>
</tr>
</tbody>
</table>
5.1.4 SOUTH WEST SUPPLY CHAIN

The south west’s supply chain companies’ ability to support and provide services to the MRE industry is both diverse and extensive, with many existing south west MRE supply chain companies having played a significant role in some of the industry’s biggest achievements.

The regions extensive supply chain capability to support MRE can be seen in Regen South West’s “Marine Energy and Offshore Wind South West Company Directory”, available at: www.regensw.co.uk. The directory is published annually and is currently in its 6th edition; listing over 300 companies either working or with great potential to work with the MRE sector.

High profile south west MRE supply chain companies include: Mojo Maritime, Falmouth Divers, Keynvor MorLift and A&P Falmouth.

*Mojo Maritime* is one of the most successful MRE supply chain companies in the UK, and is best known for its work in the field of tidal turbine installation (although it has successful worked with both wave and wind projects). Mojo Maritime has built an impressive track record and reputation in the tidal sector and continues to develop innovative and ground breaking solutions to the challenges faced in tidal technology installation. The company has won a multitude of industry awards and have an impressive client list which includes Marine Current Turbines (owned by Siemens), Tidal Generation Limited (owned by Rolls Royce), RWE npower Renewables, Ocean Power Technology (OPT), Delta Stream, Pulse Tidal, Aquamarine Power, Offshore Wave Energy Limited (OWEL) , Voith Hydro and Bauer Renewables. Mojo Maritime is based in Falmouth, Cornwall [177].

*Falmouth Divers* is one of the pioneering MRE supply chain companies of the south west, having successfully worked on the installation of the world first offshore wind farm. Falmouth Divers continues to provide services to the offshore wind sector and has in recent years also provided services to other MRE technologies. Falmouth Divers is based in Plymouth, Devon and Penryn, Cornwall [178].
**Keynvor MorLift** is a marine contractor firm which specialises in the installation and O&M of tidal turbine technology. High profile clients include Tidal Generation Limited (Rolls Royce) and Atlantis Resource Corporation. Keynvor MorLift is based in Appledore, Devon [179].

**A&P Falmouth** have successful diversified their business into the MRE sector, winning work in WEC fabrication and vessel conversion (for the MRE market), high profile clients include Seajacks, Fred Olsen, OTP and OWEL. A&P Falmouth employed a KTP associate through the University of Exeter to assist the transition of the company into the MRE sector. A&P Falmouth is based in Falmouth, Cornwall [180].
5.2 DECISION TO DIVERSIFY

5.2.1 THE DIVERSIFICATION MODEL
When a business considers diversification into the MRE supply chain, it will need to undertake a process to both gain an understanding of the MRE sector and identify the potential opportunities for their business; this process has been set-out in 7 key stages and is shown in Figure 5-15.

Figure 5-15 Diversification model
1. **The MRE sector:** Initially it will be essential for the potential supply chain company to gain an understanding of the MRE sector as a whole, gaining knowledge on technologies, policy & regulation, current sector activity and industry leading developers.

2. **Skills and services:** A key objective in assessing diversification opportunities in the MRE sector, will be to gain a comprehensive understanding of the skills and services required by the sector, this will be required to identify of potential business opportunities and transferable assets (already within the company).

3. **Locations of MRE activity:** Potential supply chain businesses will also need to identify locations of MRE activity, allowing assessment of their company’s ability to mobilise services and skills to identified activity locations.

4. **Transferable assets:** Potential supply chain companies will need to understand how they can assess their business for assets transferable to the MRE sector.

5. **Target market:** Once a potential supply chain business has undertaken all of the above steps, they can then identify their target market (or technology group).

6. **Competition:** Once the target market has been determined, key supply chain companies working in the sector (competitors) can be identified.

7. **Market entry:** The final stage in assessing diversification potential for a supply chain business will be to assess what companies or organisations (preferably locally) can assist company diversification and market entry.
The MRE sector

In the initial stage of the decision making process to diversify into the MRE sector, it will be essential for the potential supply chain businesses to gain a comprehensive understanding of the industry. General industry information required to gain a comprehensive understanding of the sector should include:

Current state of sector: Basic overview of MRE industry development, gaining an understanding of the real economic benefits obtainable through diversification into the sector. This information can be seen in chapters 3.2 of this dissertation.

Policy and Regulation: principle understanding of industry policy and regulation. This information can be seen in chapter 3.3 of this dissertation.

Technology: The differing types of technology used in the MRE sector, basic principles of operation and installation, materials and components, technology development and market leading technologies. This information can be seen in chapters 3.4 of this dissertation.

MRE resource & activity: Identification of locations of exploitable MRE resource and areas of high MRE activity. This information can be seen in chapter 3.5 of this dissertation.

Market leaders: identification of developers, contractors and supply chain companies who are leading in the sector. Information on leading technology developers can be seen in chapter 3.4 of this dissertation.
General MRE sector information can be obtained with relative ease from a basic internet search; however it may be more useful to visit websites such as: www.renewableuk.com, www.crownestate.co.uk and www.carbontrust.com, where a plethora of industry reports are available. Other effective methods of initial information gathering on the sector can be achieved through attending industry conferences, local MRE events and joining associations, these methods also present opportunities for networking with established MRE supply chain companies.

The two largest national MRE industry conferences in the UK are All Energy and Renewable UK, both of which are annual events.

*All Energy* is an ‘energy’ (encompasses all forms of energy generation, including non-renewable forms) industry conference and exhibition. The event is free to attend and has historically always been held in Aberdeen, Scotland. Details on All Energy can be found at: www.all-energy.co.uk.

*RenewableUK* host a variety of renewable energy industry events, their largest being the “RenewableUK Annual Conference” which encompasses all forms of renewable energy generation (including non-marine). The event is held in a different location each year and has been running for 35 years (previously under the name of BWEA). Details on RenewableUK events can be found at: www.renewableuk.com.

The two main bodies hosting local MRE events in the South west are *Regen SW* and *MOR*. Details can be found at www.regensw.co.uk and www.morenrenewables.co.uk.

Group membership with MRE associations is also a valuable tool when deciding to diversify into the sector; often supplying industry information and network contacts. Association memberships are available through, RenewableUK, Regen SW and MOR.
**Skills and services**

The MRE sector requires a diverse and robust supply chain; businesses operating in a variety of sector disciplines will be required in the life cycle of all technology types.

It will be essential that potential supply chain companies familiarize themselves with:

**The skills and services required by the sector**

A breakdown of the services required across the sector, can be seen in Figure 5-16.

Typical areas of expertise included:

- Engineering
- Regulation, legal and financial
- Manufacturing
- Installation
- Environmental
- Operation and Maintenance
- Testing
- Future Markets

**How skills and services required differ due to individual technology type**

Potential supply chain companies will need to understand the differing requirements of each of the technology groups.
Figure 5-16 MRE sector supply chain requirements
The skills and services required by the sector

Engineering

The engineering services required by the MRE sector are extensive and diverse, offering supply chain companies a multitude of opportunities to engage with the sector. Engineering services will be required by all MRE technology group across all levels of technology maturity. Specific services required will include:

Consultancy; MRE developers will require consultancy services to provide general assistance and advice with technology development.

Computer Aided Design (CAD); in the initial stages of developing new MRE technologies (or new components for MRE technologies) developers will commonly require the services of engineers for initial design work, this is usually undertaken using a CAD computer package. CAD allows the developer to design the technology in a 3 dimensional platform where computer generated loadings can be applied to the design to allow engineering strengths and weaknesses to be identified prior to any physical work being undertaken. In initial stages of development this service is vital, as simple changes to the technology design can be made with relative ease and at little additional cost.

Computational Fluid Dynamic modelling (CFD); it will be imperative that the developer can understand how their technology will interact with the environment. CFD computer packages will allow developers to understand how the working fluid (wind and water) acts on the technology. CFD modelling can be undertaken alongside CAD, and is generally used more prolifically in the offshore wind and tidal sector; as these technologies are directly in the path of the working fluid. It is also used in assessing fluid dynamic loadings acting on subsea foundations and moorings. CFD allows developers to understand the fluid dynamics acting on and around their device prior to deployment; if necessary alterations to initial designs can be made (prior to any physical build or deployment).
**Pure engineering (civil, mechanical, marine and electrical);** Pure engineering services will be required across all technologies from design to installation & deployment.

- Marine engineering services will be required when considering marinization of the technologies (designing and adapting the technology for the saline marine environment) and for installation and deployment procedures.
- Electrical engineering services will be required both on and offshore, for the electrical components of the power take off system of the technology and the connection of such technologies to the grid onshore.
- Mechanical engineering will be required for any mechanical or moving parts of any technologies.
- Civil engineering maybe needed in foundation design or if quaysides need improvement for use as an O&M port.
Opportunities to supply services to the MRE sector will not just be engineering and marine based, many services will be required from the regulation, legal and financial sector to support the development of MRE technologies in their path to commercialisation and through technologies O&M life cycle. Roles required in the regulation, legal and financial sector will include:

*Intellectual Property (IP) registration and patents:* In the early stages of technology development a key objective of any developer will be to protect the intellectual property (IP) of their technology design from replication by another, this is archived by registering technology patents. It is common practice for developers to required supply chain companies to sign Non Disclose Agreements (NDA) prior to any IP release.

*Consenting:* Developers may need assistance in securing and negotiating leases and licenses from national regulators. Applications to lease a designated area of seabed will need to be obtained from the Crown Estate; it is common practice that the lease will incur a fee; however actual fee values are not available in the public domain. Applications for a licence to actually operate MRE technologies offshore will need to be obtained from the Marine Management Organisation (MMO).

*Power Purchase Agreements (PPA):* legal services will be required in the setting up of PPA agreements. When a technology is ready to export electricity onto the national grid it will need to find a buyer for the electricity. A PPA is a legal contract between the electricity generator (commonly the technology developer or project developer) and the electricity buyer (commonly utility companies).

*Renewable Obligation Certificate (ROC):* assistance will also be required when setting up ROC revenue collection, this will again require assistance on business contracting and finance advice.
Insurance: Developers will require assistance in obtaining insurance for their technology. All deployed MRE technologies are required to have insurance, this is to protect both the developer and any other potential sea users from financial loss. The significance of insurance in the MRE sector is of especial importance to those developers working with emerging technologies. Emerging technology developers are commonly constrained by limited budgets; therefore, a potential financial loss due to an accident could result in catastrophic losses to the project budget and ultimately has the potential to terminate the project altogether.

Finance and business contracting: Financial and legal services will be required when creating business contracts between developers, contractors, and supply chain companies.

Access to funding & bid writing: MRE Developers may need assistance in identifying and accessing potential funding revenue streams; this is of significant importance to the emerging technology groups. Once funding streams have been identified, further assistance may be required with bid writing to access the funding.

Health & Safety: Health and safety will play a key role in MRE technology installation, deployment, and O&M; it is of highest importance that those personal installing (or working with) MRE technologies are protected from possible harm. Therefore, services in H&S both in an advisory and physical capacity will be required by the sector, to protect companies from possible litigation.
Manufacturing

The MRE sector will require a wide range of manufacturing services, due to the innovative nature of the MRE sector many technologies will require bespoke components or equipment which will need to be manufactured. There will also be additional manufacturing services required for existing equipment and components used by the MRE sector.

Structural fabrication; structural fabrication service will be required across all MRE technology types. There are two key factors when considering opportunities to supply fabrication services to the MRE sector:

- Facility size will need to be sufficient to effectively handle and supply large structures
- Location, commonly large scale fabrication is undertaken close to the intended deployment site (allowing maximum cost reductions to be made).

At present steel is the most commonly used material for structural bodies of MRE technologies; used in turbine towers, subsea jackets (turbine foundations), tidal turbine bodies and WEC devices; however WEC developers have indicated that in future some devices may be fabricated using a composite material.

Use of composite for WEC devices is favoured by developers due to the materials; light weight, high strength and inability to corrode; however large scale use of composites in fabrication of MRE structures is only likely to be seen once commercial design of the technology has been finalised.

At present most WEC devices are fabricated in steel this is due to both the embryonic nature of existing WEC devices (currently devices often require alterations which can be made using steel with relative ease in comparison to composite) and the limited budget of current developers (it is much cheaper to fabricate one-off devices using a steel material, however when multiple devices are required composites become more economically viable).
**Components:** In addition to structural bodies there will be a considerable market for MRE technology components (either manufactured or supply of ‘off the shelf’ components) this could include: blades, power take of systems and power trains, electrical components, power electronic systems, gearboxes, hydraulic systems, generators, transformers and other basic engineering components.

**Cables:** the manufacture of a variety of cables will be required by the sector, and will included; fibre optic cables, umbilical cables, power cables and cable armouring.

**Seabed attachment:** potentially innovative anchoring systems may require manufacture; this could include bespoke anchors, moorings and foundations.

**Marine paints and specialist coatings:** services in providing and manufacturing bespoke marine paints and maritime coating to prevent or mitigate corrosion will be required by the MRE sector; this is primarily due to the extensive use of steel in the sector.

**Equipment:** manufacturing and supply service of equipment used to support the MRE sector will also be required and could include manufacture & supply of:

- Navigation equipment consisting of buoys, lighting, and GPS
- Environmental monitoring equipment used for resource assessment and environmental monitoring (once a technology has been commissioned; in compliance with EIA requirements).
- Communication equipment for the transmission of data back to shore.
Installation

The services required by the MRE sector when considering the installation of the technologies can be categorised into three key areas; ports, vessels and marine operations.

Ports

Ports play a vital role in the mobilisation & demobilisation of installation vessels used in the MRE sector, key requirements of ports suitable for utilisation by the MRE sector when considering installation are;

- Extensive heavy lift capacity: a requirement of lifting several hundred tons can be commonly expected in the MRE sector.
- Load out quayside space: the size required for load out will be technology dependent and specially based on technology size; a considerably greater load out area would be required for offshore wind technologies in comparison with wave energy devices.
- Deep water approach: many vessels working in the installation of MRE technologies offshore are of significant size and would therefore have a vessel draft requiring a suitable water depth on approach to the port, it would also be beneficial if the port was accessible 24hr a day; e.g. not tide dependent. Common draft depth of installation vessels currently working in the sector are 8m or less.
- Location: port location will be key to successful unitisation by the MRE sector. Ports located close to deployment sites will without doubt successfully gain some work in the MRE sector; however the level of work gained will be dependent on the ports ability to accommodate the intended technology for installation or installation vessels, specifically the ports ability to provided sufficient lift capacity, quayside space and water depth.
Vessels

Vessel requirements for the MRE sector include the hire or procurement of installation & support vessels, vessel modification or conversion and vessel maintenance.

Possible opportunities may also include the manufacture of crew transfer vessels and ultimately potential ship building; at present the offshore wind sector is the only MRE sector to have commissioned and built bespoke vessel specifically designed for the installation of offshore wind turbines.

As both the wave and tidal sector develop, market opportunities to provide naval architecture services (vessel design) could be created; however actual vessel build is unlikely to be undertaken in the UK due to the significantly higher build cost when compared to eastern countries.

Marine Operations

Marine operation requirements for the MRE sector will demand a robust highly skilled human resource, capable of delivering complex engineering projects in challenging marine conditions. Marine operation roles will include master mariners, crew, divers & Remotely Operated Vehicle (ROV) operators.

Those working in the sector will also require a variety of professional certification, commonly required certification includes: Sea survival, working at heights, and working in confined space. Business opportunities will also be available to those organisations that can provide the relevant training and certification it may be advantageous if these courses could be held local to areas of MRE activity.
The MRE sector as a whole will required a range of environmental services, these services will include:

**Environmental Impact Assessments (EIA’s):** An EIA is a requirement of any project either on or offshore, an EIA will identify any potentially negative or beneficial impacts the project may make on the environment (intended deployment site). EIA’s are in place to protect the environment from potentially damaging activity. All technology developers will be required to undertake an EIA prior to any technology deployment.

MRE developers commonly commission independent EIA experts to undertake the EIA; this is primarily due to the extensive and exhaustive nature of EIAs.

**Subsea surveys:** another growing market opportunity within the MRE sector is the needed for subsea survey work. Prior to any technology deployment, surveys of the sea bed at the potential deployment site will need to be investigated.

In establishing sea bed characteristics developers will need to understand the topography and the geology of the intended site, this information will inform seabed attachment method and positioning of technology.

Typical work undertaken in subsea surveys include side scan technologies and core sampling.

**Environmental monitoring:** a common requirement of an EIA will be environmental monitoring at a deployment site, this is usually undertaken in two key stages a) background data and b) deployment data.

Back ground data is used to create a base line and is undertaken prior to any deployment, it is common that background data for an intended site will need to be collected over a year, prior to any technology deployment.

Once the technology has been deployed deployment data will be collected (for the duration of installation and technology operation), this can then be compared with the baseline data to establish what, if any acoustic affects the situated technology is imparting onto its local environment
Resource assessment; environmental services will be required when initial resource assessments are undertaken. Resource assessment will be required in two stages, firstly to identify potential sites of MRE natural resource and secondly when a developer is investigating a potential deployment site for their technology, where a more detailed resource assessment is likely to be required. Off the shelf and bespoke equipment can be used to measure actual resource characteristics however additional services will be required for data analysis.
Operation and maintenance requirements for the MRE sector can be categorised into three key areas;

**Personnel Transfer:** services will be required in the MRE sector for the transfer of personnel offshore; this will include the provision of: high speed crew transfer vessels and helicopters (Helicopters are not commonly used in the MRE market at present. As offshore wind farm move a further distance offshore helicopter use in crew transfer may become a viable and safer method of personnel transport).

There will also be additional business opportunities to provide services for the maintenance of crew transfer vessels and or helicopters.

**Personnel:** services will be required to provide a skilled work force to undertake offshore technology maintenance requirements. Market opportunities include providing relevant training courses (survival at sea, working at heights) and trained personnel.

**Safety Equipment:** services providing personnel safety equipment, such as harnesses (working at heights) life jackets and survival suites (transfer) and PPE (Personal Protection equipment; including gloves, masks, eye protectors, and steel toe cap boots).

**Diagnostic Equipment:** services will be required to provide diagnostic equipment to allow quick and effective assessment of technology maintenance requirements.

**Components:** providing general maintenance engineering components & supplies such as oils, lubricants and parts.

**Quayside Access:** providing services to allow safe and effective personal transfer from quayside to crew transfer vessels.
Testing

In the road to commercialisation of both emerging MRE technologies and in the optimisation of commercial technologies, a plethora of bespoke testing services and facilities will be required. Services required will include provision of:

**CAD and CFD:** initial load testing and fluid dynamic interaction can be assessed (tested) via computer software such as CAD and CFD modelling.

**Tank Testing:** scaled model testing of technologies can be initially undertaken in testing tanks, where physical simulation of acting forces (wave, tide & wind) can be reproduced at the appropriate scale to determine proof of concept in technology design.

**Reliability Testing:** facilities are usually designed for a specific component of a specific technology e.g. wind turbine blades, testing can often be undertaken using a scaled or full scale version of the individual component.

**Sea Trials:** facilities usually include a designated (pre consented) sea area where sea trials of MRE technologies can be undertaken; such facilities are usually not always grid connected.

**Full Scale Testing:** facilities usually include a designated (pre consented) sea area where full scale MRE technologies can be deployed; such facilities are usually grid connected.

**Array testing:** facilities usually include a designated (pre consented) sea area where multiple (full scale) MRE technologies can be deployed; such facilities are usually grid connected.
**Future markets**

The skills and services required by the MRE sector will change over time, as technology matures and large scale array sites come online, there will be a move away from testing and a shift towards the O&M market.

As all technologies reach commercial stage, new markets will emerge, such as the planning, management and undertaking of the decommissioning of devices once they have reached the end of their service life.

It is also possible in the future that new technology will be developed to support the mass generation of all renewable energy technologies; a potential huge future market for the renewable energy sector is energy storage technology.

It is well publicised that renewable energy technologies are intermittent in their power production, if in the future technology could be designed to effectively and economically store electrical energy (allowing the user to access energy at any given time), this could secure a significant percentage of the MRE market as well as assisting in achieving government target to reduce CO2.
How skills and services required differ due to individual technology type

Opportunities for supply chain to engage with the MRE sector are technology maturity dependent, it is imperative that businesses wishing to diversify into the sector understand the difference in current market opportunities for each of the technologies.

Each of the four stages of the development pathway (set out in Table 5-7); concept, prototype, demonstration and commercial, will requires a different groups of services and skills, the changes to supply chain requirements through technology development can be seen in Figure 5-17.

![Diagram of supply chain requirements through technology development](image)

**Figure 5-17** Supply chain requirements through technology development
Concept

The concept stage of the development pathway will require services for:

*Engineering*: developing initial design work, often requiring services in CAD and CFD computer based modelling.

*Legal and financial*: securing IP patents, developing the economic modelling of the MRE project and assisting in identifying and applying for possible grants or funding streams.

The opportunities for the supply chain at concept stage are very limited financially, however there are opportunities to build relationships with developers which may result in winning more work.

Current MRE technologies at concept stage include wave and floating offshore wind (floating structure only) technologies.
**Prototype**

The prototype stage of the development pathway will require services for:

**Engineering:** structural engineering design and consultancy

**Legal and financial:** a continuation of services utilised in the concept stage and securing insurance.

**Manufacturing:** fabrication of model or full scale technology at low volume, commonly a singular ‘one-off’ device.

**Installation:** consultation and creation of installation work procedures and undertaking the marine operations for the installation of prototype device.

**Environmental:** deployment site investigation (not needed if deployed at designated test site), resource data analysis and environmental monitoring

**Testing:** scaled model tank testing and sea trials.

The opportunities for services in manufacture, installation and environmental services would are limited, and focus on small one-off projects.

Early stage prototype projects offer limited economic benefit to the supply chain; however the value of the experience gained by such projects cannot be underestimated. Prototype stage technologies offer supply chain companies an opportunity to build reputation and gain experience in the sector, which are vital assets for successful diversification.

Current MRE technologies at prototype stage include wave, tidal and floating offshore wind (floating structure only) technologies.
**Demonstration**

The demonstration stage of the development pathway will require similar services to the prototype stage; however services required will be on a larger scale. Demonstration stage is based on proof of economic viability, energy generation, reliably and survivability of the technology on a commercial scale. Additional service requirements will include:

*Engineering*: device optimisation, reliability analysis and engineering modelling of array interactions.

*Legal and financial*: a continuation of services utilised in the prototype stage

*Manufacturing*: fabrication of full scale technology, possibly multiple devices.

*Installation*: consultation and creation of installation work procedures and undertaking the marine operations for the installation of full scale or an array of devices.

*Environmental*: EIA’s, deployment site investigation and environmental monitoring

*Testing*: full scale deployment at grid connected site.

*O&M*: in-situ maintenance (offshore), maintenance personnel and device/component recovery.

Opportunities to engage will be greater (than prototype stage) due to the diverse project requirements, however economic benefit to the supply chain will be limited by the relatively short life span of the projects (demonstration projects are commonly only deployed for 12 - 24 months).

Current MRE technologies at demonstration stage include tidal and offshore wind (turbine optimisation only) technologies
Commercial

The commercial stage of the development pathway will require similar services to the demonstration stage; however services required will be on a much greater scale, where tens or hundreds of devices will need to be deployed and maintained, offering service requirement periods of tens of years. Additional service requirements will include:

Engineering: design for mass manufacture and cost reduction.

Legal and financial: continuation of services utilised in the demonstration stage

Manufacturing: mass (production line) manufacturing of technologies and components.

Installation: cost reduction optimisation for mass installation of technology, undertaking the marine operations for technology installation and associated infrastructure

Environmental: continuation of services utilised in the demonstration stage

O&M: continuation of services utilised in the demonstration stage on a large scale.

The opportunities for the supply chain at commercial stage are very lucrative; however there will be high competition from experienced multi-national companies.

Current MRE technologies at demonstration stage include offshore wind technologies only.
Locations of MRE activity

It will be necessary for potential supply chain companies to familiarise themselves with the locations of MRE activity in the UK and overseas. Current areas of MRE activity in the UK are shown in chapter 3.5.

The location of MRE activity will differ depending on technology type (due to location of resource) and technology maturity. MRE activity with prototype, demonstration and commercial technologies will generally be centred on fixed geographical location where technology installation is undertaken; however concept technologies are unlikely to be graphically fix, therefore allowing them to be more flexible and when applicable move location (especially relevant to testing facilities).

The location of MRE activity can also play a significant role in a potential supply chain company’s ability to win MRE related work, and will specially be based around two key factors:

Distance from potential supply chain company to site of MRE activity.
Potential supply chain companies located nearby or locally to sites of MRE activity may be competitively at an advantage, due to ease of access (convenience) and low transport costs (this is primarily applicable to those company’s who’s assets are not mobile).

However development of niche services and facilities (such as bespoke testing facilities) may act as an incentive for developers to travel further.

Potential supply chain company ability to mobilise services
Potential supply chain companies who can mobilise their services, skills and equipment to anywhere in the world are competitively at an advantage; the ability to move services to any location allows potential supply chain companies to compete equally with local (geographically) supply chain companies. Winning work will be dependent on experience, ability and cost rather than location.

The ability to mobilise service is of especial important in the current MRE market; as locations of MRE activity are diversely spread across the UK and the globe.
**Transferable assets**

In the process of assessing if diversification into the MRE sector is of benefit to a potential supply chain company, the business will need to assess what skills or services (if any) they currently have which could be utilised by the MRE sector.

Any existing skills or expertise within the business applicable to MRE should be utilised in the first instance to support and facilitate diversification, new and additional services can be obtained once diversification has been undertaken.

When assessing any business for transferable assets utilisable by the MRE sector, initial assessment should follow the process shown in Figure 5-18.

![Figure 5-18 Assessment of transferable assets process](image-url)
**Potential Assets**

In the first instance a potential supply chain company will need to identify any existing skills, services, facilities or equipment that could be utilised by the MRE sector; this process can be undertaken using the information shown in Figure 5-16. Companies working in or supplying services to the marine or engineering sectors are likely to have existing skills and services directly transferable to the MRE sector.

**Usability**

Once potential transferable assets have been identified, further assessment will be required to understand if the existing assets can be transferred directly or if additional changes or improvements are required.

An indicator of directly transferable assets will be the scale of technology at which the potential supply chain company already works with, an example would be a small and large port; The large port is likely to have deep water berthing, extensive lift capacity and significant load out quayside space as it works with large container ships, in comparison a small port may have assets which in theory could be used by the MRE sector but are not sufficient in scale or size to actually be utilised.

**Improvements**

The next step will be in assessing what (if any) improvements to the potential asset are required for it to become utilisable by the MRE sector. Assets can be categorised into two groups; physical and intelligence.

- **Physical asset** (such as a fabrication facility, port or vessel) utilisation will be determined by scale and size. There will need to be consideration if the asset would need to (or in some cases could) be up-scaled, expanded or re-developed to accommodate MRE technologies.

- **Intelligence asset** (such as professional personnel in any relevant discipline) utilisation will be determined by knowledge, experience and relevant certification. There will need to be consideration if the asset would need further educated or trained to a relevant qualification for utilisation in the MRE sector to take place.
Cost

The cost of required improvements will be the key indicator in the decision to diversify into the MRE sector, commonly improvements required on physical asset can be expected to incur medium-high capital costs, as Improvements required on intelligence asset can be expected to incur very low-low capital costs.

*Medium-high capital costs* could include; ship building and vessel conversion (vessel designed specifically for MRE technology deployment & installation), Fabrication/manufacturing plant expansion (to accommodate size of MRE technologies), improvements to quaysides and berthing (for O&M personnel transfer), investment in infrastructure (such as heavy lift cranes).

*Very low-low capital costs* could include; reading industry papers & publications (information gathering) attending industry events (networking), undertaking training (for relevant computer software (CAD and CFD packages) and offshore certifications (sea survival, working at heights etc.)), purchasing relevant CAD and CFD software, employing the services of an external consultant or university to support company diversification and joining relevant MRE associations (gaining support & networking).

When considering the cost of improvements consideration should also be taken on any other potential uses for the asset in other sectors, improvements to intelligence assets are likely to be more focused on the specifics of the MRE sector and may not be as easily transferred to other sectors, physical asset improvements however have greater potential to be utilised by other sectors (e.g. increased quayside space in a port could be utilised by any activity within the port.) and potential bring in other revenue streams.
Viability

This is the final process when assessing transferable assets for the MRE sector within a company. If existing assets can be directly transferred to the MRE sector (with little or no negative impact on current business activity) then it is an obvious decision to diversify and make additional use (revenue) of existing assets.

However if improvements are needed the capital layout of such improvements will need to be justified against predicted revenue generation. When considering predicted revenue generation for justification of capital layout, it will be important that a potential supply chain company take two key factors into consideration; technology maturity and locations of activity.

Technology maturity is an important factor when considering capital expenditure and predicted revenue, the risks associated with investing in emerging technologies is far greater than that of commercial technologies. It will be of great importance that potential supply chain companies identify all the risks associated with investment and understand when large scale revenue generation is predicted.
Risks when investing in improvements of assets to provide services to emerging technology markets

- The technologies used in the emerging technologies market (wave, tidal and floating wind) are unproven on a large or multiple scales, there is almost a certainty that some technologies will fail to reach commercial stage with a possibility that some markets will fail altogether.
- Technology designs have not yet converged to a standard design (which has been seen in the wind energy market, e.g. the three bladed wind turbines), designs to technology may change or scale up/down, with the potential to dramatically alter required facilities or services.
- Commercial stage achievement of emerging technologies is unknown, and therefore it is hard to predict when large scale revenue generation will begin; utilisation of assets may happen in 5 years or 30 years.
- Technology development may move outside of the UK. Currently the UK is leading in MRE technology development, however if the UK fails to provide the right support technology developers require, they may look to move their technologies to another country (where greater incentives are available).

Advantages to investing in improvements of assets to provide services to emerging technology markets

- Due to the emerging nature of the technologies there is only a limited amount of competition; therefore a unique asset could be a great advantage. It will be important to understand where the asset sits (or would be used) within the technology development pathway to ensure demand for the asset is a current market opportunity.
**Risks when investing in improvements of assets to provide services to commercial technology markets**

- Limited amount of technology types; the only MRE technology to currently have reached commercial stage is offshore wind.
- Commercial MRE technologies have an abundance of existing supply chain companies, therefore steep competition can be expected; It will be of great importance that any investment is used to obtain an asset which is either in high demand (ability to obtain market share) or unique (creating a niche market). Competitors in the offshore wind sector are likely to be large companies with extensive knowledge and experience of the sector.
- Generally the technology and kit used in commercial markets (offshore wind) is on a large scale, therefore creating physical assets utilisable by commercial markets are likely to incur high capital costs.

**Advantages to investing in improvements of assets to provide services to emerging technology markets**

- Revenue generation is easier to predict, the planned roll out of round 3 offshore wind farms in the UK has been clearly set out by the UK government, giving installed capacity and expected installation and operation dates, using this as a guideline can help in assessing what and when revenue will be generated.
- The technology used in commercial MRE technologies is proven and design converged, allowing any investment to be tailored to exact technology.
Location is also an important factor when considering capital expenditure and predicted revenue. Due to the location of natural resources and designated MRE deployment sites, specific locations within the UK will be better suited to exploit the MRE market. When investing in new assets consideration should be taken to understand what technologies the asset applies to, where the asset will be based (can the asset be mobilised?) and where current (and planned) technology activity is taking place (location of market demand).

Investment in any assets which cannot be mobilised (such as the expansion of a port or fabrication facility) should be undertaken with caution. Assets which cannot be mobilised will need to be situated close to the locations of activity for utilisation to take place.

Investment in any assets which can be mobilised (such as personnel, vessels, equipment) can be undertaken with less caution, however consideration should be undertaken to understand how easily assets can be mobilised and the costs involved.

Opportunities

Once all of the above processes have been completed and a business has identified their transferable asset and decided to diversify into the MRE sector, they will need to begin identifying market opportunities, target market groups and competition; this may be undertaken with the support of a local MRE association, University or an external consultant.

The business should also consider undertaking branding and marketing work to advertise their new service, attending & exhibiting at MRE industry events and could also consider looking for collaborative work with either other supply chain companies or consortium projects (such as TSB projects) to win initial work in the sector.
Target market

When identifying a potential supply chain company's target market (market entry point) several factors will need to be considered:

What is the motivation for diversification?

Beyond the obvious financial gain in diversification, other motivations experienced by potential supply chain company may include:

The desire to gain new skills and expand core business services

When the motivation of diversification into the MRE sector is to gain new skills and expand core business services, the potential supply chain company should consider focusing initial effort on business partnering and collaboration work.

Partnering with an existing MRE supply chain company to win work, allows the potential supply chain company to provide services (their expertise) to the MRE sector while learning from the experienced business partner. It will be imperative that the potential supply chain company has either a niche (or significant) skill or service they can bring to the partnership (without which, there is little to entice an experienced supply chain company into the partnership).

Working collaboratively with supply chain companies, contactors and technology developers will expose potential supply chain companies to the requirements of MRE projects in a knowledge sharing (learning) environment. The very nature of collaborative work also acts as an excellent networking tool.

The desire to build brand credibility and reputation in the sector

When the motivation of diversification into the MRE sector is to build brand credibility and reputation, then the potential supply chain company should consider focusing initial effort on the emerging technology groups.

Winning work with emerging technologies (wave energy) can be easier for new supply chain companies, due to the reduced competition (in comparison with commercial technology markets) and the immaturity of the sector (where benchmarks and market leaders are not yet identified).

Projects within the emerging technology sector are often constrained by limited budgets and therefore any work in this field is unlikely to create large revenue
initially; however the experience gained will assist any company in obtaining a credible reputation in the field.

Potential supply chain companies wishing to win work in the emerging technologies group will need to focus efforts on providing niche services and skills and working collaboratively with technology developers and other supply chain businesses, through consortium projects such as TSB projects.

*The desire to generate new revenue streams*

When the motivation of diversification into the MRE sector is purely based on generating a new revenue stream in the short term, then the potential supply chain company should consider focusing initial effort on the *commercial technology groups*.

Winning work with commercial technologies (offshore wind) is a highly competitive market; where competition can be expected to offer significant experience and a proven track record.

Projects within the commercial technology sector can be very lucrative financially; however the sector is already saturated with experienced companies offering work in this field.

Potential supply chain companies wishing to win work in the commercial technologies group will need to focus efforts on networking, building working relationships and winning work with tier 1 contractors.

*What services can I offer to the MRE sector?*

Identification of skills, services, equipment, facilities and transferable assets that are within the potential supply chain company (which could be utilised by the MRE sector) will need to be undertaken. See chapter 5.2.1 for information on service and skill requirements as well as transferable assets.

Consideration should be taken on: technology type, scale & size and development maturity, all of which can help in assessing target markets (usually undertaken though a process of elimination).
Am I located near an area of MRE activity?

Identification of areas of MRE activity in the UK will need to be undertaken. See chapter 3.5 for information on locations of MRE activity. Consideration should be taken to identify any areas of MRE activity which are in close proximity to the potential supply chain company; this may help in assessing target markets.

**Competition**

Further research will be required at this stage to identify key industry players and competitors in the identified target market group.

![Diagram](image)

**Figure 5-19 identifying competition**

Identification and primary research of leading technology developers, leading supply chain companies and local supply chain companies working in the field identified as the target market will need to be undertaken.

In some cases (primarily with commercial technologies) technology projects will be managed independently of the technology developer, where an external project management company (tier 1 contractor) will develop the MRE project. Therefore identification and primary research of leading MRE project developers in the field identified as the target market may also need to be undertaken. Primary research should include but is not limited to: company background, parent or group association, location of company, MRE project history, MRE project locations, future MRE projects and niche MRE markets.

Identification of the above will allow potential supply chain companies to identify competitors and potential clients of the future.
**Market entry**

Once a potential supply chain company has decided to diversify into the MRE sector, it would be of befit to said company to identify any bodies or associations who may be able to support their business in diversification and market entry.

**Trade Associations**

Initially it may be more successful to contact local MRE associations for diversification support rather than national bodies such as renewable UK, as they will be able to inform you of supply chain opportunities locally and offer local networking opportunities.

South west based MRE associations, who can provide information and support in entering the MRE supply chain, include: Regen SW, the MOR group, Cornwall Marine Network and Invest in Cornwall.

**External Consultant**

Some MRE supply chain companies have used the services of an external consultant in assisting their business in diversification into the MRE sector.

Use of external (experienced sector experts) consultants can be an effective support tool, when diversifying any business. The use of consultant can accelerate the potential supply chain company understanding of the sector and assist in identifying potential businesses opportunities.

**Local Universities**

Market entry support for potential supply chain companies can also be achieved through utilising the services of local universities.

Businesses wishing to enter the MRE sector can accelerate their progress in diversification by enlisting and partnering with academic bodies such as universities and institutes.

Universities can offer academic support and further assistance by embedding knowledge into industry through placement of associated PhD and Masters Students, Research Assistants, and through the KTP (Knowledge Transfer Partnership) scheme.
There are two main bodies in the south west which can provide information on relevant graduate employment and KTP programs, namely: The University of Exeter and The University of Plymouth.

5.2.2 RECOMMENDATIONS

The following recommendations are aimed at a potential south west supply chain company wishing to engage with the MRE sector.

**Recommendations for diversification**

In order for a potential south west supply chain company to make an informed decision on the viability of diversification into the MRE sector, it is recommended that the ‘decision to diversify model’ set out in chapter 5.2.1 should be used.

The ‘decision to diversify model’ set outs 7 key requirements, which will need to be undertaken by a potential south west supply chain company, these are:

1. **The MRE sector**
2. **Skills and services**
3. **Locations of MRE activity**
4. **Transferable assets**
5. **Target market**
6. **Competition**
7. **Market entry**

Assessment of the above will allow businesses to quickly gain an understanding of the real opportunities for their business in the MRE sector.
5.3 SUPPLY CHAIN QUESTIONNAIRE

In assessing opportunities for potential south west supply chain companies to engage with the MRE sector it will be essential to open a discussion with those south west based, supply chain companies already working in the MRE sector, and those organisations that are currently engaging and supporting MRE supply chain companies in diversification into the sector.

5.3.1 SUPPLY CHAIN COMPANY DATABASE

Discussion with existing MRE supply chain companies, will allow the challenges and successes experienced by the supply chain when engaging with the sector to be identified.

A total of 39 supply chain companies were identified as working in the MRE sector in Devon and Cornwall, from which two databases were compiled:

- Identifying 23 companies operating within Cornwall (Appendix C: database of MRE supply chain companies in Cornwall).
- Identifying 16 identified companies operating within Devon (Appendix D: database of MRE supply chain companies in Devon).

Companies included in the database have been classified in the following areas of expertise;

Manufacture: Covering the full or part manufacture of any MRE technology or component in any material, and also includes assembly of full or part of any MRE technology.

Port Facilities: Covering all port facilities capable of utilisation by the MRE sector, including; mobilisation & demobilisation of vessels, technology load out, heavy lifting and quayside space.

Hydrographical: Covering bathymetry and geological investigation, primarily used for site investigation and allowing suitable foundations and installation methods to be identified.
**Consultancy:** Covering a wide range of consultancy services for the MRE sector, including but not limited to; engineering & computational analysis, site investigation, installation procedures, market entry assistance, resource assessment, resource data analysis, funding and investment assistance and technology development.

**Testing Facilities:** Covering a wide range of testing facilities which may be utilised by the MRE sector for technology & component development. In Devon and Cornwall specifically such facilities include; wave & tidal tank testing, moorings testing, dynamic cable testing, sea trials and full scale grid connected array testing.

**Civil Engineering:** Covering all aspects of civil engineering for the MRE sector, including; improvement, design & construction of quays, ports and subsea structures.

**Vessels:** Covering all vessel requirements of the MRE sector, including the procurement and hire of vessels used in the MRE sector. Vessels used in the sector include; small work boats, crew transfer vessels, Installation barges, dynamic positioning and heavy lift vessels.

**Support service:** Covering a wide and varied range of services that may be utilised by the MRE sector. Specifically in relation to the sample group includes; design & manufacture of pontoons and brows for crew transfer, ship chandlers and site development.

**Hydraulics:** Covering consultancy, design and installation of hydraulic systems used on MRE technologies and on vessels working in the MRE sector.

**Environmental:** Covering environmental service requirements of the MRE sector, including resource characterisation, acoustic monitoring (throughout the full life of the project), EIA and many other environmental studies or monitoring which may be required.

**Marine Operations:** Covering all aspects of marine operations working in the MRE sector, including; Master Mariners, skippers, vessel crew, divers, ROV operators and the safe operation of heavy lifting at sea.
5.3.2 ENGAGEMENT ORGANISATIONS DATABASE

In establishing successful methods of engagement with the MRE supply chain it will also be imperative to include discussion with organisations that are currently engaging and supporting MRE supply chain companies in diversification into the sector, allowing previously successes engagement methods to be identified while also understanding where engagement failed.

A total of 5 engagement organisations were identified as supporting MRE supply chain companies, from which the following database was compiled:

- Identifying 5 engagement organisations operating in the UK (Appendix E: database of UK organisations engaged with MRE supply chain companies).

Companies included in the database are:

RenewableUK is a membership based national renewable energy trade association which supports the development of wind and marine energy in the UK.

Regen South West (Regen SW) is a membership based regional renewable energy trade association which supports the delivery of renewable energy projects and energy efficiency in the South west of England.

The Marine Offshore Renewable (MOR) Group is a regional member based partnership of established market-leading MRE supply chain companies delivering solutions to complex and challenging marine renewable projects.

Cornwall Marine Network (CMN) is a regional organisation dedicated to supporting the marine sector in Cornwall via initiatives that improve profitability and encourage growth through quality and innovation.

Invest in Cornwall (IiC) is a regional inward investment company, focused on promoting Cornwall as an ideal business location and attracting investment. IiC have 6 focused industry sectors, of which renewable energy is included.
5.3.3 UNDERSTANDING ENGAGEMENT WITH THE MRE SECTOR

The supply chain business questionnaire

In order to gather information and opinions from supply chain companies working in the MRE sector the following questionnaire, was put to the companies identified in Appendix C and Appendix D. The questionnaire template can be seen in Appendix F, a copy of the questions only can be seen below.

<table>
<thead>
<tr>
<th>QUALIFYING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has your company ever worked or won work in the MRE sector?</td>
</tr>
<tr>
<td>2. Does your company have aspirations to work in the MRE sector?</td>
</tr>
<tr>
<td>3. How long has your business been working in the MRE sector?</td>
</tr>
<tr>
<td>4. As a percentage, how much of your company turnover is generated from work in the MRE sector?</td>
</tr>
<tr>
<td>5. What technology sectors are you working or hope to work in?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNDERSTANDING THE OPPORTUNITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Reflecting on your decision to enter the MRE market; what was the initial trigger that prompted you to investigate opportunities in the industry further.</td>
</tr>
<tr>
<td>7. Once initially interested what steps did you take to understand the market, to allow you to identify potential opportunities for your business?</td>
</tr>
<tr>
<td>8. Reflecting on your decision to enter the MRE sector, what market analysis would have been useful to you in the decision making process?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARKET ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Thinking back to your initial experiences in the industry, what were the first activities you undertook to support your market entry?</td>
</tr>
<tr>
<td>10. What (if any) new products or service development was required in your diversification/entry into the sector?</td>
</tr>
<tr>
<td>11. When thinking about initial market entry what methods of market communication did you undertake or find useful to your business?</td>
</tr>
<tr>
<td>12. What support would you like to see for businesses wishing to enter the MRE market?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BARRIERS TO MARKET ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. During your company’s transition into the sector what barriers did you experience which delayed or limited your market entry success?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BARRIERS TO BUSINESS GROWTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Thinking now about your business today; what are the barriers preventing your MRE business from growing?</td>
</tr>
<tr>
<td>15. What support does your business require to grow its MRE activities?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. What would you do differently if you were entering the market today?</td>
</tr>
<tr>
<td>17. What key recommendations would you make for a fellow business deciding to enter the MRE market?</td>
</tr>
</tbody>
</table>
The supply chain business support tools feedback form

In addition to the questionnaire, individuals identified in Appendix C and Appendix D, were also asked to indicate which of the following 53 industry support tools they have found or would find useful to their business. The support tools feedback template can be seen in Appendix G, a copy of the list can be seen below.

<table>
<thead>
<tr>
<th>THINKING ABOUT EVENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Meet the Buyer events</td>
</tr>
<tr>
<td>2. Meet the supplier events</td>
</tr>
<tr>
<td>3. Sharing exhibition space with other MRE supply chain companies</td>
</tr>
<tr>
<td>4. Local MRE conferences</td>
</tr>
<tr>
<td>5. Local MRE exhibitions</td>
</tr>
<tr>
<td>6. Local industry representation presenting at national industry events</td>
</tr>
<tr>
<td>7. Grants to exhibit at industry conferences</td>
</tr>
<tr>
<td>8. Grants to attend industry conferences</td>
</tr>
<tr>
<td>9. Grants for marketing material (graphics, stands, brochure, leaflets)</td>
</tr>
<tr>
<td>10. Organised meetings at conferences (UKTI, Inward investment)</td>
</tr>
<tr>
<td>11. Journalist days; inviting a group of journalist to South west to showcase MRE.</td>
</tr>
<tr>
<td>12. Overseas trade mission; groups of companies exhibiting at international events</td>
</tr>
<tr>
<td>13. Business exchange; groups of companies touring to meet with key suppliers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THINKING ABOUT THE WEB</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. Support and advice for the web</td>
</tr>
<tr>
<td>15. Grants for web design</td>
</tr>
<tr>
<td>16. A dedicated industry website</td>
</tr>
<tr>
<td>17. Video's showcasing South west MRE offer</td>
</tr>
<tr>
<td>18. Dedicated MRE social media outlets (linked in, twitter, you tube)</td>
</tr>
<tr>
<td>19. Social media management (updating social media outlets)</td>
</tr>
<tr>
<td>20. Free MRE image bank</td>
</tr>
<tr>
<td>21. Web based advertising</td>
</tr>
<tr>
<td>22. Online business planning tools</td>
</tr>
<tr>
<td>23. Web based shared areas</td>
</tr>
<tr>
<td>24. Messaging service for South West MRE companies</td>
</tr>
<tr>
<td>25. MRE tender alerts</td>
</tr>
<tr>
<td>26. MRE news alerts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THINKING ABOUT THE MEDIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. MRE supply chain catalogue/directory</td>
</tr>
<tr>
<td>28. Press releases</td>
</tr>
<tr>
<td>29. Arranged media liaison</td>
</tr>
<tr>
<td>30. Industry awards</td>
</tr>
<tr>
<td>31. Magazine</td>
</tr>
<tr>
<td>32. Newsletter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THINKING ABOUT SALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>33. Sales training</td>
</tr>
<tr>
<td>34. Business advice</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
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<tr>
<td>35.</td>
</tr>
<tr>
<td>36.</td>
</tr>
<tr>
<td><strong>THINKING ABOUT FINANCE</strong></td>
</tr>
<tr>
<td>37.</td>
</tr>
<tr>
<td>38.</td>
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<tr>
<td>39.</td>
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<td>40.</td>
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<td>41.</td>
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<tr>
<td>42.</td>
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<tr>
<td>43.</td>
</tr>
<tr>
<td><strong>THINKING ABOUT ACCESS</strong></td>
</tr>
<tr>
<td>44.</td>
</tr>
<tr>
<td>45.</td>
</tr>
<tr>
<td>46.</td>
</tr>
<tr>
<td><strong>THINKING ABOUT TRAINING &amp; QUALIFICATIONS</strong></td>
</tr>
<tr>
<td>47.</td>
</tr>
<tr>
<td>48.</td>
</tr>
<tr>
<td>49.</td>
</tr>
<tr>
<td><strong>SPECIFICALLY DESIGNED FOR THE SOUTH WEST MARINE ENERGY INDUSTRY</strong></td>
</tr>
<tr>
<td>50.</td>
</tr>
<tr>
<td>51.</td>
</tr>
<tr>
<td>52.</td>
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<tr>
<td>53.</td>
</tr>
</tbody>
</table>
The engagement organisations questionnaire

In order to establish successful methods for engaging the MRE supply chain, the following 10 questions were put to the companies identified as engaging with the MRE supply chain (Appendix E: database of UK organisations engaged with MRE supply chain companies). The questionnaire template can be seen in Appendix H, a copy of the questions only can be seen below.

<table>
<thead>
<tr>
<th>QUALIFYING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does your organisation engage with MRE supply chain companies?</td>
</tr>
<tr>
<td>2. How long has your organisation been engaging with MRE supply chain companies?</td>
</tr>
<tr>
<td>3. As a percentage how much of your organisation’s activity is based around the MRE Sector?</td>
</tr>
<tr>
<td>4. What MRE technology sectors does your organisation engage with?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNDERSTANDING YOUR ENGAGEMENT WITH THE MRE SUPPLY CHAIN SECTOR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. What activities has your organisation undertaken to engage with MRE supply chain companies?</td>
</tr>
<tr>
<td>6. How does your organisation encourage businesses to diversify into the MRE sector?</td>
</tr>
<tr>
<td>7. What would make it easier for your organisation to engage with the MRE supply chain?</td>
</tr>
<tr>
<td>8. How does your organisation support the growth of MRE supply chain businesses?</td>
</tr>
<tr>
<td>9. What barriers have you experienced when attempting to engage with the MRE supply chains?</td>
</tr>
<tr>
<td>10. In your opinion what support should be made available to encourage businesses to diversify into the MRE sector?</td>
</tr>
</tbody>
</table>
6. RESULTS

6.1 QUESTIONNAIRE RESULTS

6.1.1 RESULTS OF THE SUPPLY CHAIN BUSINESS QUESTIONNAIRE

The following results have been taken from the respondents of the supply chain business questionnaire. It should be noted that Questions 6 – 17 were not limited to a single answerer and therefore some companies interviewed gave multiple answers to questions.

A total of 15 interviews were undertaken with supply chain companies, consisting of 11 companies from Appendix C (achieving a hit rate of 48%) and 4 companies from Appendix D (achieving a hit rate of 25%).

![Pie chart showing geographic distribution of supply chain sample base](image)

Figure 6-1 Supply chain sample base geographic

The total sample base consisted of 73% based within Cornwall and 27% based within Devon.
1. **Has your company ever worked or won work in the MRE sector?**
100% of the sample group are working in the MRE supply chain sector.

2. **Does your company have aspirations to work in the MRE sector?**
Not applicable, See question 1 results

3. **How long has your business been working in the MRE sector?**

![Pie chart showing duration of business MRE activity]

Figure 6-2 duration of business MRE activity

47% of the sample have worked in the MRE sector for over 5 years, equally 47% of the sample have been working in the sector between 1-5 years, and only 7% of the sample have been working in the sector less than a year.
4. As a percentage how much of your company turnover is generated from work in the MRE sector?

The majority (67%) of those interviewed generated less than 25% of their company turnover from MRE related activity, the second largest group (27%) generated over 75% of their business revenue from MRE activity, a small minority (7%) generated 50-75% of their business revenue from MRE activity. None of the sample generated 25-50% of their business revenue from MRE activity.
5. **What technology sectors are you working or hope to work in?**

The majority (73%) of those interviewed either worked or hoped to work with all technology sectors of the MRE industry, the second largest group (13%) worked with wave & tidal technologies only.

A small minority (7%) worked with wave & floating wind technologies only and offshore wind, wave & tidal technologies only.
6. Reflecting on your decision to enter the MRE market; what was the initial trigger that prompted you to investigate opportunities in the industry further?

![Figure 6-5 Prompt to investigate opportunities in MRE sector](image)

**Word of mouth**

The majority of the sample had initially entered the sector due to word of mouth; in most cases the business was directly approached by a previous client and asked to tender for work or informed of a potential opportunity.

Many of the companies interviewed were already working in the marine operations sector, and therefore had existing skills & services that were required to support the MRE sector.

In some cases there was a direct market pull, where developers approached companies directly and asked for products/services. In one case opportunities were highlighted by another department (independent environmental research) within the company.

**Local event or MRE group**

Some interviewees stated that the initial decision to enter the MRE market was triggered by local MRE events or groups, specifically; initial consultation and subsequent meetings on the Wave Hub test facility, Regen SW renewable energy events, CMN member messaging service and local university activities; such as PRIMaRE.
Media

Interviewees were also alerted to the opportunities in the MRE sector through the media, specifically; through general maritime news (shipping, diving, marine engineering) and local publicity (flyers, newspapers, television).
7. **Once initially interested what steps did you take to understand the market, to allow you to identify potential opportunities for your business?**

![Figure 6-6 Steps taken to understanding the market](image)

**Skills Assessment**
Over half of the companies interviewed undertook an informal assessment of the skills in their business. Many recognised that skills already existing within their business (maritime skills, marine operations, engineering, diving) were directly transferable to the MRE sector.

**Market Research**
Over half of the companies interviewed undertook some form of market research. Research undertaken primarily focused on identifying; project opportunities available today, project opportunities of the future (including stages of development and deployment dates), MRE project developers and tier 1 contractors (client contact details), technologies used in the sector and how they work (identifying components).

**Events & Networking**
The majority of companies found it very useful to attend MRE events in order to gain a deeper understanding of the market and to increase industry contacts via networking; events attended were on a national & regional level.
External Assistance

A small group of companies used external assistance to support diversification into the sector. External assistance methods included: independent consultants, knowledge transfer partnerships (KTP) and Technology Strategy Board (TSB) projects.

None

A minority of companies undertook no actions to deepen understanding of the MRE sector, many simply responded to demand.

7.2 Who undertook this work?

The majority of initial actions taken by supply chain companies to deepen understanding of the MRE market were undertaken by the interviewee or by another member of staff within the company.
8. Reflecting on your decision to enter the MRE sector, what market analysis would have been useful to you in the decision making process?

![Figure 6-8 information desired for decision making process](chart.png)

**Market Status**

The majority of companies interviewed would have found clear and honest market analysis information very useful in the diversification decision making process, specifically;  *Who:* Identification and contact information of technology developers, project developers, site developers and tier 1 contractors.  *Where:* Identification of MRE project locations.  *What:* Identification of technologies used in the sector, specifically identifying technology maturity level.  *When:* Identification of expected deployment dates for projects and technologies.

Those interviewed commonly stated that the above information would allow supply chain companies to identify opportunities and customers to target, both now and in the future. Clear visibility of the role out of MRE projects will enable business to forward plan their market growth in the MRE sector.

It will be essential that the quality of the information is accurate and realistic; historically the sector has over promised on the opportunities for the supply chain.
Market Position
Several companies would have liked detailed information on the complexity and tiered system of the MRE supply chain, allowing them to identify where to position their business in the market and their direct customers, contractors and suppliers.

Product Application
Supply chain companies also stated they would like to receive individually tailored market research into how their product or service can be utilised in the MRE market.

Skills
Market analysis into the skills required in the sector both now and in the future was also stated as useful information.
8.2 How would you like to receive this information?

The majority of those interviewed preferred to receive market analysis in the form of a report when making the decision to diversify into the MRE market.

8.3 Would you have been prepared to pay for this information?

The majority of those interviewed believe that market analysis should be provided to supply chain companies free of charge, although some companies would be prepared to pay for the information if the quality of the information was considered exclusive.
Thinking back to your initial experiences in the industry, what were the first activities you undertook to support your market entry?

Events & Networking
Attending and exhibiting at national and regional MRE events was stated as the most common ‘first activity’ undertaken by supply chain companies entering the sector. Many stated that the most useful element of attending events was the opportunity to network and make named contacts. Attending events also proved useful in general market information gathering.

Trade Associations
Many supply chain companies found it useful to join MRE trade associations on both a national and regional level, groups joined included; Renewable UK, Regen South West and the MOR group.

Joining associations gave supply chain companies access to; market information, opportunities to exhibit and attend events, mentoring, 1:1 advice, networking and facilitating meetings with potential customers.

Many stated joining regional associations as a useful tool to network with other local companies working in the MRE sector, which in some cases lead to business partnerships (SME’s partnering together to win larger contracts).
Direct Approach
A small number of companies carried out market research to identify their customer base and approached them directly.

New Products
A small minority of the interviewees invested in the development of new products and services.

Advertising & Marketing
Many companies undertook some form of advertising or marketing, focusing on new products or services supplied to the MRE sector, common methods of marketing included: websites, exhibition stands, press releases, TV interviews (local news), data/fact sheets and brochures.

Advertising on a national level (trade news) was not considered a very effective method of brand promotion and work generation, however targeted advertising tailored to individually identified contacts was considered very effective.

External Assistance
A small group of companies used external assistance to support diversification into the sector. External assistance methods included; independent consultants, Knowledge Transfer Partnership (KTP) and Technology Strategy Board (TSB) projects.

9.2 Who undertook this work?

![Figure 6-12 How initial activates were undertaken](image)

The majority of supply chain companies ‘first activities’ were undertaken by the interviewee or by another member of staff within the company.
10. What (if any) new products or service development was required in your diversification/entry into the sector?

No New Products
Many of the companies interviewed were already working in the marine sector and had existing skill and products that were directly transferable to the MRE market and therefore no new product or service development was required; companies simply rebranded same skills and services for a different market.

Training & Qualifications
Training, qualifications and certification were stated as necessary requirements for some companies to gain, in order to diversify into the MRE market.

*Training & qualification* requirements were generally focused on upskilling existing members of staff, typical qualifications required included; sea survival, working at heights, working in confined spaces and software training (engineering design).

*Certification* requirements were generally focused on the business itself and were necessary in order to gain acceptance as a contractor to project developers, typical certifications required included; Health & Safety, Environmental Management and Quality Assurance.
Equipment
A small minority of companies were required to invest in new equipment (more prevalent as industry standards have increased) and computer software used in engineering design & modelling to facilitate diversification.

Procedures
A number of companies were required to develop new procedures, mainly focused on marine operation activities and driven by an increase in industry standards. New procedures include; Robust planning, detailed work procedures, innovative solutions to new marine challenges, design reporting and engineering design.

New Products
Over half the companies interviewed developed new products or services in their diversification into the sector, development methods included; prototyping, independent testing and product optimisation for the MRE market. Some SME’s found it advantageous to partner with other businesses to develop new products (reducing capital requirement).

10.2 What support would you like to see for new product or service development?

![Figure 6-14 Support desired for new product/service development](image)
Funding
A large proportion of those interviewed believed that access to funding would be the most effective way to support new product or service development. However current processes to access funding are considered too onerous. Those interviewed stated that the processes to access funds needed to be made easier for SME’s or alternatively assistance should be offered to support SME’s when applying for funding.

It was also stated that it would be preferable to businesses if the funds could be released directly to the company, allowing work to be undertaken internally by those who have a deep knowledge of the company and the expected deliverables.

Intended uses for funding included; prototype demonstration, provision of facilities (for testing), software licencing, marketing (of new product), independent product testing and access to structural engineers.

Mentoring
A large proportion of those interviewed believed that mentoring and 1:1 advice would be a useful way to support new product or service development. It is important to businesses that the mentoring service is delivered by a knowledgeable individual with an extensive understanding of the sector and a high level of professionalism.

Specific topics for mentoring advice included; marketing new products, identifying new markets, identifying potential customers, assistance in recruiting high calibre employees, business to business networking, assistance in identifying potential business partners, assistance in making contact with large international/national companies, support in innovation, sales support and assistance in gaining recognised certification (H&S, Environmental, Quality etc.).
Access to Equipment & Facilities
Support to facilitate SME’s access to equipment and facilities was considered to be useful by half the supply chain companies interviewed.
Specific access requirements included; marine operations equipment (high cost and low availability), manufacturing facilities (tooling & machining), assistance in equipment procurement and access to test facilities (tank and open sea).

Training
Access to training and qualifications in respect to new product or services development was also stated as a useful tool by some supply chain companies.
Specific training and qualifications required included; sea survival, working at heights, working in confined spaces, commercial diving, ROV operation and rigging.

Industry Standards
Several businesses stated that the creation of industry certification standards would be very useful to all businesses operating in the MRE sector, specifically;

- Standardising supply chain requirements for pre-qualification (ISO, H&S, environmental etc.)
- Standardising individuals’ requirements to work in the sector (sea survival, working at heights, confined spaces etc.)
- Standardised guidance on leasing and licencing for sea & seabed designation – guidance from Crown Estate (CE) and Marine Management Organisation (MMO).
- Standardised state supported training programs to deliver industry recognised qualification & certification standards, up-skilling those in the workforce and assistance in gaining experience.
11. When thinking about initial market entry what methods of market communication did you undertake or find useful to your business?

![Bar chart showing market communication methods]

**Figure 6-15 market communication methods**

**Trade Associations**
Many supply chain companies found it useful to join MRE trade associations to assist in market communication.

Associations assisted supply chain companies by, providing sector information, assistance in advertising, inclusion in supply chain directory (Regen SW & MOR website), delivering networking opportunities and assisting conference and exhibition attendance.

**Events & Networking**
The majority of supply chain companies interviewed attended and exhibited at MRE conferences, to assist market communication.

**Marketing & Advertising**
A significant percentage of supply chain companies interviewed undertook some form of advertising or marketing, focusing on brand promotion and new products or services supplied.
11.2 Who undertook this work?

Figure 6-16 Human resource used for market communication

The majority of companies interviewed stated that initial market communication was undertaken by the interviewee or by another member of staff within the company.

11.3 Which was the most useful?

Figure 6-17 methods undertaken for market communication

The majority of supply chain companies interviewed stated that attending events and networking was the most useful market communication tool.
12. **What support would you like to see for businesses wishing to enter the MRE market?**

![Figure 6-18 Desired support for market entry](image)

**Market Research**

The majority of supply chain companies stated that clear, honest and easily assessable market analysis information would be very useful to business wishing to diversify into the MRE sector. Specifically identification of: potential customers, project locations, technologies used in the sector and expected deployment dates for projects and technologies.

Other useful market research included; MRE news alerts, MRE tendering opportunity alerts, independent expert evaluation of current technologies; identifying the technologies which demonstrate real potential, identification of technology developers with potential to base themselves in the South West and strategic documentation illustrating planned and predicated MRE market demand.

**Funding**

A small minority would like to see more funding assistance for early stage prototype developers, in order to create a market.
Marketing & Events
Some of those interviewed would like to see more support directed towards supporting SME’s, to: exhibit at MRE events, attend & host business to customer events (meet the buyer) and marketing support to develop company brand and assist market penetration.

Mentoring
Half of those interviewed stated they would like to see mentoring assistance, in: getting onto tier 1 contractor pre-qualification lists, identifying market entry level position (where does my business sit within the MRE supply chain), general business activities, supporting UK supply chain in winning MRE work (competition from international companies), introduction service (identifying supply chain capabilities and customer needs and creating business introductions) and direct mentoring from tier 1 contractors (offering advice on what is actually required re: operations, procedures, requirements and pre-qualification).

Collaboration
A few companies would like to see support offered to assist networking and encourage business to business collaboration. Specifically; support to encourage communication between large organisations and SME’s, increased knowledge sharing, assistance in setting up joint ventures and creating partnerships with the aim of gaining commercial contracts.

Training & Standards
The minority of those interviewed stated they would like to see support for training, qualifications, company certification and creation of industry standards.
12.2 How do you think this could best be delivered?

The majority of supply chain companies interviewed stated that a dedicated organisation, focused on developing and delivering MRE business to the South West would be the most useful way to deliver support to supply chain businesses.
13. During your company's transition into the sector what barriers did you experience which delayed or limited your market entry success?

![Figure 6-20 Barriers to MRE market entry](image)

**Industry Maturity**

The biggest barrier experienced by supply chain companies was stated as the lack of development in the sector; opportunities for supply chain to engage with the MRE sector has been very limited in the South West, and only those who could mobilise their services beyond the South West have achieved market penetration.

**Contracting & Competition**

A large percentage of those interviewed have found contracting complex and onerous, specifically when contracting with a large international company (pre-qualifying requirements, time & resource intensive, proving adequate size & stature).

Intensive competition for the offshore wind market has made it difficult for SME’s to win contracts. Larger businesses have greater purchasing power and can offer economies of scale by tendering for entire services and sub-contracting specialist work to smaller businesses.
### Funding

A minority of those interviewed stated that difficulty in accessing funding, specifically funding for capital expenditure (equipment procurement, product development, & marketing) was a barrier to market entry.

### Skills & Experience

A small number of those interviewed stated that gaining the opportunity to demonstrate their company’s capabilities and develop credibility in the sector was a barrier to market entry.

**13.2 Thinking about these barriers, how best do you think they could be overcome?**

![Bar Chart](image)

**Figure 6-21 Removing barriers to MRE market**

The majority of supply chain companies interviewed stated that professional introductions would be the most useful way to remove barriers to market entry success. Specifically: assistance and support in promoting South West offer & supply chain capabilities to larger organisations, providing showcasing meetings (where different South West SME’s visit large organizations and pitch products/services).
**Thinking now about your business today; what are the barriers preventing your MRE business to grow?**

![Barriers to growth chart]

**Figure 6-22 Barriers to growth**

**Sector Maturity**
The biggest barrier experienced by supply chain companies was stated as the lack of development in the sector as a whole, leading to an inconsistent workload (project based) and therefore does not give the continuity needed for investment and business growth.

**Competition**
The second largest barrier to growth was stated as the high competition for skilled staff (due to very high day rate payments offered by larger companies) reducing an SME’s ability to recruit and expand workforce.

**Location**
Location was also considered a barrier to some interviewees due to the limited MRE market demand in South West, specifically for those companies who could not mobilise their services outside of the South West.
NDA’s
A small number of those interviewed found the limiting nature of Non-Disclosure Agreements (NDA’s) a barrier to growth. Specifically NDA’s have historically prevented supply chain companies from publicising previously successful MRE work.

Funding
Access to funding (a limited balance sheet reduces opportunities to tender for work) was stated as a barrier to growth. Specifically, processes to access funding are currently too onerous, with a focus on written quality of applications rather than product/project merit.
15. What support does your business require to grow its MRE activities?

![Figure 6-23 Support required for growth](image)

**Market Growth**

The majority of interviewees stated their business would require greater market demand (market growth) to allow their business to grow.

Specifically; national development support of the sector to increase MRE projects based in the UK (with a focus on attracting projects to the South West) and promoting the services available in the UK (including supply chain) on an international level.

Support method could include: simplification of regulatory requirements on developers, better communication locally of the opportunities, research into the barriers developers face (allowing solutions to be identified) and long term programs of funding for the development of the sector.

**Business Support**

Many of those interviewed require more business support, specifically assistance in: increasing competitiveness, marketing and website development, attending events and assistance in creating business partnerships.
Finance
A small number of those interviewed stated they required access to funding, specifically easier access to borrowing ensuring finance is available to small business.

Customer Information
A small number of those interviewed stated they would require assistance in identifying customers and customer needs at an international level.

Skills & Training
Some interviewees stated they would require assistance in recruiting skilled and experienced individuals to increase their workforce.

15.2 How would you like this support to be delivered?

The majority of supply chain companies interviewed stated that a dedicated organisation; focused on developing and assisting the growth of supply chain campiness the most useful way to deliver support.

Support should include: industry news alerts, tendering opportunity alerts, personal introductions, marketing support, assistance to access funding and general business support for growth.

The supply chain as a whole is very diverse and therefore support offered will need to be tailored to each individual company.
16. *What would you do differently if you were entering the market today?*

![Figure 6-25](image-url)

**Nothing**
The majority of companies interviewed stated they would do nothing different in their market entry method, based on their existing success.

**Identify Customer Base**
A minority of those interviewed stated they would have dedicated time to identify their direct customers. Specifically approaching tier 1 companies and not developers (developers don’t commonly contract directly with supply chain) and target directly.

**More Resource**
A small number of companies would have recruited more staff to assist in market entry and win more work (resource needed for market entry was underestimated).

**Identify Partners**
A small number of interviewees stated they would have identified potential business partners at the outset to: reduce capital costs (can be shared), win larger contracts (increase capability) and assist market entry (if partner already working in MRE sector, market penetration will be easier).
Marketing
A large amount of those interviewed stated they would have undertaken more marketing. Specifically would have widely publicised first successful jobs in the sector, developed brand recognition and direct marketing to named individuals in named positions.

Delayed
A small number of companies stated (in hindsight) they would have delayed their market entry due to limited business opportunities at present.
17. What key recommendations would you make for a fellow business deciding to enter the MRE market?

![Figure 6-26 Recommendations](image)

**Know the Market**
Research the industry and familiarise yourself with industry jargon and acronyms. Keep up-to-date with industry developments.

Understand the opportunities for your business and when those opportunities are likely to become a reality; current market opportunities are very small.

**Know your Capability**
Understand your company’s capabilities; will you need to develop new products/services? Will you require capital? Be realistic in what you can deliver. Where possible take any opportunity to work in the sector; experience is essential for market entry. Assess how easy or difficult it will be for your company to diversify and assess if it is worthwhile.

**Be Flexible**
Be flexible in your ability to mobilise your products and services; opportunities in MRE in the South West are very limited.
Know your Customers & Stakeholders
Identify your direct customers (not always developers, can be tier 1 contractors) and engage with relevant stakeholders (regulators & licencing bodies).

Innovate
Very important to offer innovative solutions (offer something different, create niche markets). Businesses who fail to innovate or offer something different will struggle to enter the market due to high competition.

Join Trade Associations
Learn more about the sector and network with other supply chain companies, though joining MRE trade associations (local were considered particularly useful)

Network & Events
Attend Industry events (especially any which are local or free); good for information gathering and networking.

Know your Competition
Research and understand your competition and attempt to offer something different, also consider what you can do to increase your competitiveness.

Caution
Urge caution and be prepared to wait. The market is still very embryonic and opportunities are few and limited, where possible offer services applicable to other industries (not 100% MRE based).
6.1.2 RESULTS OF THE SUPPLY CHAIN BUSINESS SUPPORT TOOLS FEEDBACK FORM

In addition to the questionnaire 12 of the 15 supply chain companies interviewed also completed the supply chain business support tools feedback form, the results can be seen below.

Figure 6-27 Support tools feedback form Results

Generally all the tools listed were considered useful to supply chain businesses, however some tools were considered considerably more useful than others. The following list highlights those tools that were commonly thought most useful and least useful:

**Useful Tools**

The most useful tools (shown in blue) were established to be:

- **Question 1:** Meet the buyer event
- **Question 4:** local MRE conferences
- **Question 8:** Grants to attend industry conferences
- **Question 27:** MRE supply chain catalogue/directory
- **Question 28:** Press releases
- **Question 37:** Grants for capital expenditure
- **Question 50:** Dedicated South West MRE Website
Less Useful Tools

The less useful tools (shown in red) were established to be:

- **Question 13:** Business exchange
- **Question 19:** Social media management
- **Question 22:** Online business planning tools
- **Question 30:** Industry awards
- **Question 31:** Magazine
- **Question 33:** Sales training
- **Question 36:** Access to meeting rooms
- **Question 39:** Grants for sales training
- **Question 51:** Dedicated South West MRE Magazine
6.1.3 RESULTS OF THE ENGAGEMENT ORGANISATIONS QUESTIONNAIRE

The following results have been taken from the respondents of the UK organisations engaged with MRE supply chain company.

A total of 5 interviews were undertaken with UK organisations engaged with MRE supply chain, as identified in Appendix E (achieving a hit rate of 100%).

![Pie chart showing sample base geographic distribution]

Figure 6-28 Engagement organisation sample base geographic

The total sample base consisted 20% national based, 40% South West England based and 40% Cornwall based.
1. **Does your organisation engage with MRE supply chain companies?**
100% of the sample is engaging with MRE supply chain sector companies.

2. **How long has your organisation been engaging with MRE supply chain companies?**
40% of the sample have been engaging with the UK MRE supply chain for over 5 years, equally 40% of the sample have been engaging with the UK MRE supply chain for up to 5 years and only 20% of the sample have only been engaging within the last year.

![Figure 6-29 duration of engagement with MRE supply chain](image-url)
3. As a percentage how much of your organisation’s activity is based around the MRE Sector?

40% of the organisations interviewed focused up to 15% of their total activity specifically on MRE activity, equally 40% of the organisations interviewed focused 15-30% of their total activity specifically on MRE activity and only 20% of the organisations interviewed dedicated 50% or more to MRE activity.

Figure 6-30 Percentage of MRE focused activity
4. **What MRE technology sectors does your organisation engage with?**

60% of the sample is engaging with all technology sectors of the MRE industry, 20% of the sample is only engaging with offshore wind, wave & tidal technologies and 20% of the sample is only engaging with offshore wind & wave technologies.

![Figure 6-31 technology type engagement](image)
5. What activities has your organisation undertaken to engage with MRE supply chain companies?

![Figure 6-32 methods on engagement with supply chain](image)

Conferences & Networking
Provision of: industry dedicated conferences, exhibitions & networking events, on both a national & regional level. Some organisations also promoted the MRE sector at other related industry events (marine sector).

Workshops
Organisation of MRE related workshops, specifically; stakeholder engagement, business collaboration to win work, working with local government and research and technology development.

Marketing & PR
General marketing and promotion of MRE sector and the UK supply chain at an international, national and regional level. Other marketing activities included: email marketing, articulating the MRE offer in Cornwall for inward investment, creation of the South West MRE supply chain directory, website assistance and general business promotion.

Introductions
Organising formal introductions to developers and potential customers and assisting in business-to-business introductions to promote collaboration & business partnerships.
**Business Support**
A wide range of business support was offered by all organisation interviewed. Support included: assisting MRE supply chain companies to attend and exhibit at industry events, developing a new ‘Marine Energy Supply Chain Tool’ which will highlight market opportunities and gaps in supply chain (due to launch 2013), hosting of the MOR group (dedicated MRE group), promoting supply chain through website, hosting industry awards, support for market entry and engaging with stakeholders.

**Market Information**
Providing the dissemination of industry knowledge (news, projects & opportunities).
6. **How does your organisation encourage businesses to diversify into the MRE sector?**

![Bar Chart](image)

**Figure 6-33** Encouragement for diversification into MRE sector

**Events**
Provision of industry events with a focus on winning business and highlighting market opportunities (regionally).

**Market Analysis**
Researching and analysing local business capability in order to identify those with potential to enter the MRE supply chain market (then approach directly).

Mapping of the MRE industry and its national supply chain, to allow gaps in market to be identified and highlighting market opportunities.

**Co-Promotion**
Creating an environment of co-promotion between members, where group members are encouraged to promote the benefits of joining the MRE supply chain sector to their clients and suppliers.

**Mentoring**
Through approaching businesses (with potential to join the MRE supply chain market) with direct mentoring and support for MRE market entry and assistance in finding investment.
7. **What would make it easier for your organisation to engage with the MRE supply chain?**

![Figure 6-34 methods of engagement with supply chain](image)

**Dedicated Point of Contact**
The nomination of a dedicated single point of contact (PoC) for trade associations (e.g. Renewable UK, SWMEP, Regen SW & MOR).

**Market Research**
Clarity on capabilities and gaps in the UK MRE supply chain, allowing strengths and weaknesses to be identified and the creation of a national and regional database of companies operating in the MRE supply chain sector.

**Access to Key Players**
Providing access to presentation speakers for MRE events (assisting in attracting larger audiences).

**Support for Market Growth**
Concentrated focus by central government on developing the UK MRE market. Focused activities should include: project deployments in South West and UK, creation of the right environment for investment and attracting investment, simplification of legislation, development of MRE training programs and linking up MRE activity across the UK.

**Funding**
Funding to enable support delivery to companies working in the MRE supply chain.
8. How does your organisation support the growth of MRE supply chain businesses?

Figure 6-35 supporting growth in MRE supply chain

Mentoring
Mentoring and advice on market opportunities for supply chain businesses. Other mentoring services included: encouraging and assisting in business collaboration, supply chain development, market entry information, advice on funding streams and assistance for marketing.

Training
Advice on training courses and applying for training grants.

Networking & Events
Hosting networking events and assisting businesses in attending and exhibiting at other industry events.

Marketing
Provision of marketing support for businesses in the MRE sector, including: conferences exhibition stands, brochures, websites, national press releases and delivering marketing training.
Industry Development (Market Growth)
Developing the MRE industry as a whole by: promoting the sector to other industries, engaging with stakeholders (with an aim to bring forward developments) and promoting globally the capabilities of the South West (including: energy resource, supply chain, test facilities and academic institutes) in order to attract developers, projects and investment.

Introductions
Facilitating business-to-business introductions with the aim of increasing collaboration.
9. **What barriers have you experienced when attempting to engage with the MRE supply chain?**

![Figure 6-36 barrier to engaging with supply chain]

**Access to Key Players**
Difficulty in attracting key industry players and developing quality content for MRE conferences.

**Events**
Difficulty in attracting large numbers of supply chain companies to local MRE events; due to supply chain availability.

**Funding**
General lack of available finance in the sector for both developers and supply chain development. Lack of funding in the sector has a detrimental effect on the rate of growth and reduces supply chain opportunities.

**Business Support**
Supply chain companies sometimes lack an understanding of the services and support offered. Supply chain businesses are not receiving enough support to penetrate tier 1 supply chain and compete with large international companies.

**Supply Chain Visibility**
The geographical fragmentation of the UK supply chain hinders visibility of sector capability.
10. In your opinion what support should be made available to encourage businesses to diversify into the MRE sector?

Figure 6-37 Desired support for encouragement into diversification to the MRE sector

**Funding**
Grants and funding should be made available for: marketing, training, new product development, conference attendance and for incentivising developers to move MRE projects to the UK and the South West.

**Market Information Database**
Creation of MRE knowledge database to include: compressive mapping of the sector identifying opportunities, explanation of supply chain tier system and advice on where/how to enter, list of current and future projects and developers, market gaps and solutions needed, general market knowledge sharing (to move industry forward), research into skill requirements for the sector and tendering information alerts.

**Business Support**
Assistance to support: diversification into offshore wind sector, and how to compete with tier 1 contractors and large international companies, overcoming pre-qualification requirements and gaining accreditations/certification, building business confidence to diversify into MRE sector, working collaboratively or in partnership with other supply chain companies and general business support and advice on how to grow business.

**Marketing & Networking**
Assistance in brand development, market exposure and free networking events.
6.2 RECOMMENDATIONS

The following recommendations are aimed at a potential south west supply chain company wishing to engage with the MRE sector.

6.2.1 RECOMMENDATIONS FOR INITIAL ENGAGEMENT

When a potential south west supply chain company wishes to initially engage with the MRE sector, the following actions are recommended.

**Attend Industry Events**

In the first instance potential south west supply chain company should consider attending MRE industry events, on both a national and regional level.

National industry events expose potential supply chain companies to the current activities of the MRE sector on a national and global level. Where key industry players are likely to be in attendance and possible network opportunities may be present.

Local industry events will alert potential supply chain companies to opportunity which may be present at a local level and network opportunities with local MRE supply chain companies; potentially identifying future business partners.

**Recommendations** include attending: All Energy, Renewable UK Annual Conference & Wave & Tidal Conference, Regen SW Annual Conference, Regen SW Green Energy Awards and SWMEP Events

**Digest industry reports**

In the initial stages of engagement with the MRE sector, it will be important that the potential south west supply chain company gains a comprehensive knowledge of the sector and current activities, this can be archived through digestion of industry reports (many are available online) consider reports based globally, nationally and locally.

**Recommendations** include visiting the websites of: Renewable UK, The Carbon Trust, The Crown Estate and Regen SW.
6.2.2 RECOMMENDATIONS FOR MARKET ENTRY

When a potential south west supply chain company wishes to enter the MRE market, the following actions are recommended.

Join MRE associations

When first considering market entry, it would be wise for any potential south west supply chain company to utilise the services of MRE supply chain associations through joining memberships.

Market entry support is offered by a variety of MRE supply chain associations, support methods can included: tailored 1:1 advice, network contact details, access to networking events, access to reduced cost exhibition at industry events, industry reports and assistance in setting up business-to-business meetings.

It is advisable that companies entering the MRE market join both national and regional; although in the first instance local supply chain associations are likely to be most useful.

Recommendations include joining the following associations:

- Renewable UK
- Regen SW
- MOR

Understand pre-qualifications requirements

When considering winning work in the MRE sector, a potential south west supply chain company will need to gain an understanding of the pre-qualification requirements (training, accreditation and certification) their company many need to acquire in order to win work with large tier 1 contractors. This information may not be easy to find directly, and is likely to required conversation with both other MRE supply chain companies and MRE supply chain associations.

Recommendations open a dialogue with:

- MRE supply chain associations
- Other MRE supply chain companies
**Identifying potential business partners & competitors**
When considering market entry, a potential south west supply chain company will need to identify potential business partners, competitors and niche markets.

**Recommendations** include using services of local MRE association such as:

- Regen SW
- MOR

**Building Alliance**
Building strong relationships with other MRE stakeholders will be essential for a potential south west supply chain company wishing to enter the MRE market.

Use of the triple helix approach is advised, the triple helix encompasses government, academia and industry stakeholders; this approach can provide a strong alliance which can be used on all fronts of the MRE sector; maximising exposure and opportunities.

This combined effort is of particular importance when considering opportunities to work with emerging technologies, where much of the current activity in this sector can be seen in research & development while being heavily driven by policy and funding.

**Recommendations** include engaging with:

- The SWMEP
- Local universities
- Local authorities

**Marketing**
Marketing of new services will be essential when a potential south west supply chain company diversifies their business.

**Recommendations** include:

- Exhibiting at industry events
- A targeted marketing campaign aimed at selected
7. DISCUSSION

7.1 SUMMARY

In summary an evaluation of the opportunities for south west supply chain companies to engage with the MRE sector, was undertaken using the recognised evaluation tool: SWOT analysis.

SWOT analysis can be a useful tool to gain a broad overview of a chosen topic/project, and specifically identifies:

- **Strengths**: Advantages specific to the project (cost competitive, location, delivery timescales, experience, equipment and infrastructure).
- **Weaknesses**: Disadvantages specific to the project (high cost, location distance, lack of experience, equipment & infrastructure).
- **Opportunities**: elements that could be exploited by the project (gaps in market, niche markets, limited competition, collaboration)
- **Threats**: elements that could be cause disruption or ultimately failure of the project (regulatory change (change in policy and/or tariffs), economic factors (fluctuation in currency), competition, funds (assess to funding), timeframes).

The four steps of SWOT analysis commonly fall into two categories; internal and external; where strengths and weakness are generally evaluated internally to the project, and opportunities and threats are external to the project.

The SWOT tool was chosen as it can help identify “opportunities” quickly while also providing insight into strengths, which can be promoted, and weakness which can be improved.

The results of the SWOT analysis undertaken can be seen in Figure 7-1
7.1.1 THE STRENGTHS

The south west has many strengths when considering MRE, notable the natural marine energy resource, unique R&D facilities, sector leading supply chain and the work to date of the SWMEP; all make the south west a natural choice for development of MRE technologies.

**Resource**

The south west is home to an extensive offshore marine energy resource, capable of delivering up to 9.2 GW [3], this is a unique and natural asset for the south west, where few other regions in the UK can boast the same capacity.

**SWMEP**

The creation of the SWMEP demonstrates the UK government’s commitment to developing the MRE sector in the UK and specifically a centre of excellence in the south west.

Achieving ‘Marine Energy Park’ status increases creditability and visibility in the sector, there are currently only two ‘Marine Energy Parks’ in the UK.
Supply Chain
South west based MRE supply chain companies are successfully winning work both inside and outside of the region, with some companies winning work on an international level.

The ability to provided key sector skills and services will be essential in the delivery of an MRE CoE. The south west supply chain is capable of delivering skills and services on a local level while offering unique expertise and an international track record.

R&D
The south west’s R&D capability is exceptional, with few regions in the world capable of offering real competition.

R&D capacity in the south west includes bespoke testing facilities; which range widely in services offered, and can be used to develop technology from any point in the technology development pathway.

R&D academic institutes in the south west includes The university of Exeter, Plymouth, Bristol and Bath as well as other dedicated R&D institutes such as the National Composite Centre (NCC) and Plymouth Marine Laboratory.

7.1.2 THE WEAKNESSES
The south west will have weaknesses when considering MRE; these will need to be known to allow mitigation actions to be identified. Notable weaknesses of the south west MRE offer included, limited tidal marine energy resource, which in turn leaves the south west vulnerable to dependency on specific technologies, and poor internal (regional) communication.

Resource
Although the south west is home to a plethora of excellent MRE resources, much of this resource would only be utilisable by wave and floating wind technologies, the south west will experience some opportunities with offshore wind through the build-out of the round 3 Bristol channel zone and more specifically through the construction and operation of the ‘Atlantic Array’ wind farm site.
The south west however is limited in offering commercially attractive tidal resource sites, it may however be able to play and R&D role in the development of the Lynmouth Tidal Test (LTT) site, which could be used as a nursery (test) site for tidal turbines designed to generate at lower current velocities and in shallower water.

**Technology Dependent**

As the majority of the south west’s commercially exploitable MRE resources would only being utilisable by floating wind and wave energy technologies, the south west is vulnerable to technology specific dependency.

The south west ability to build a thriving MRE sector with mass job creation and volumes of work is directly reliant on the development of floating wind and wave energy technologies; both of which have yet to achieve commercialisation.

It will be important that the south west continues to offer strong R&D facilities to support the development of both wave and floating wind technologies.

**Communication**

The south west marine energy offer, as described in the SWMEP prospectus is a collaborative approach, with complimenting facilities and services across the region, however communication between facilities and service providers has historically been limited (primarily due to NDA’s).

In developing a robust MRE offering and maximising supply chain opportunities in the south west, there will need to be a shift in current ‘regionally internal’ communication, specifically around lead generation.

The orchestration of both lead generation information gathering and dissemination would need to be undertaken by a knowledgeable and neutral party such as, SWMEP, Regen SW or a local council.

**7.1.3 THE OPPORTUNITIES**

The opportunities for the south west when considering MRE, will need to focus on providing new services in new ways, this will require, diversification innovation, mobilisation and collaboration.
**Collaboration**

A successfully proven route for diversification into the MRE sector has been engagement with the sector through collaborative R&D projects.

R&D project calls have historically been managed by relevant bodies and institutes such as, Technology Strategy Board (TSB), Department of Energy and Climate Change (DECC) and Energy Technology Institute (ETI).

Collaborative R&D projects often consist of a technology developer, an academic collaborator and a private sector (supply chain) company as a minimum, it is not uncommon to have more than one academic or supply chain companies involved in a single project.

The projects offer supply chain companies an opportunity to build strong working relationships with the other parties within the collaboration group, as well as other networking opportunities.

All of the south west’s leading MRE supply chain companies have been involved with R&D collaboration projects at some point, and in most cases the association to the project was the initial opportunity for diversification.

**Mobilisation**

At present the most successful MRE south west supply chain companies have been those who have won work outside the region. The ability to mobilise services and key assets to any location, give supply chain companies a key advantage.

Not all services required will need to be physically mobile, much work in consultancy and design can be achieved over the internet, however some service such as fabrication and manufacture are likely to stay localised opportunities.

**Niche Markets**

Many of the services required by the MRE sector have been identified in this dissertation, however simply offering these services up to the sector will not be enough for successful diversification.

Supply chain companies working in the MRE sector should as a matter of course always be looking at providing new and innovative solutions.
7.1.4 THE THREATS

Any new immature sector will have many threats mainly in the form of uncertainty which in turn increases risk, it will be important when considering MRE in the south west that the threats to the growth of a MRE CoE are identified early allowing decision making to happen with full visibility of risk involved. Notable threats to the development of MRE in the south west are the timeframe in which work can be expected, market demand and access to finance.

**Time frame**

Projects such as the ‘Atlantic Array’ are not expected ‘online’ until 2020, this is mainly due to the challenging task of offshore wind farm installation. Many of the large contracts for the ‘Atlantic Array’ are expected to be awarded to experienced international firms.

Localised opportunities for the south west supply chain to engage with the ‘Atlantic Array’ is likely to be realised in the O&M operations of the farm, and therefore job creation (in volume) on a regional level cannot be expected until 2015 and beyond.

The time frame for the realisation of commercial (100 MW+ farms) scale technology developments in the south west waters (e.g. wave and floating wind) is likely to be 2020 and beyond.

In the period up to 2020 it is expected that technologies such as wave energy will develop from prototype devices to 30MW ‘first stage’ arrays, therefore it will be imperative that the south west continues to develop its R&D capability, allowing the region to maintain an ‘attractive offer’ to technology developers.

**Market demand**

The time frame expectation of the marine energy sector results in fewer opportunities for engagement at present, and limited opportunities in the immediate future, with volumes of work and strong market demand expected 2015 and beyond.
Supply chain companies who chose to wait for more certainty in the market, run the risk of losing out to others who have developed with the sector; building relationships, experience and reputation.

Engagement with the sector can be realised in the short term through collaborative R&D projects, prototype work being undertaken at one of the regions testing facilities and also through winning working outside the region.

**Finance**

Access to finance or more specially lack of access to finance for MRE development is the largest threat faced by the sector.

Currently large scale investment in the sector has been limited, with only a few utility companies investing in MRE technologies.

In more recent years there has also been investment in MRE technologies through acquisition, this has been seen with Siemens purchase of Marine Current Turbines Limited (MCT) and Rolls-Royce purchase of Tidal Generation Limited (TGL), both technologies saw a marked acceleration in the development of their technology through acquisition and investment.

Essentially most technology developers have been required to self-fund their projects, this has been achieved through small private investments, partnerships and through grants such as TSB, DECC and ETI.

### 7.2 DISCUSSION

Currently the main opportunities for the south west supply chain to engage with the MRE sector are outside the south west and through R&D collaboration projects.

If the south west is to become a successful centre of excellence for MRE technologies, there will need to be many full scale array deployments in south west waters; this will require development of current wave and floating wind technologies.

Currently wave and floating wind technologies are at an early stage of development and it is therefore imperative to the success of the south west’s that wave and floating wind technologies continue their journey to
commercialisation; This will require a strong R&D offering to attract developers to the south west and develop technology.

Technology development is a high-risk high-cost activity, as technologies move closer to commercialisation the risks reduced slightly; however the costs increase significantly, first array wave energy projects are likely to be tens of millions pounds.

Access to finance for technology developers is the largest threat to the MRE sector and has even greater significance for emerging technologies such as wave and floating wind technologies. If the south west can increase access technology developers have to finance this would be a significant advantage for the region, such finance could be provided in the form of prizes, grants and loans.

The largest barrier faced by the supply chain is the market demand time lag between now and when large volume work is predicted in 2020. Supply chain are faced with difficult decision to invest now when work is in low volume and low revenue but allows their company to develop credibility or wait until work is in high volume and high revenue but with high competition; those companies who wait may simple miss the opportunity presented buy this new sector.

In order for the MRE sector to grow and reach its full commercial potential it will require the services of the private sector, skills and knowledge from the academic sector and political support from the government; known as the triple helix approach.

Once wave and floating wind technologies have reached commercial stage the south west will have an abundance of opportunities of engagement.
8. CONCLUSION

8.1 AIM & OBJECTIVE

Reflecting on the four original aims & objectives of this dissertation

- Gain a broad understanding of the MRE sector in the UK.
- Identify diversification opportunities for their business.
- Identify transferable assets or skills, utilisable by the MRE sector
- Understand the challenges and successes faced by others working in the south west MRE sector.

The following conclusions can be made for each objective;

8.1.1 UNDERSTANDING THE SECTOR

Objective: Gain a broad understanding of the MRE sector in the UK.

The dissertation covers a substantial wealth of knowledge on the; state of sector, business opportunities, regulation & policy, resource & current activity, test sites, support associations and infrastructure for the MRE sector, which exists in the UK; this can be seen in Chapter 3.

Chapter 3 of this dissertation has been intentionally written in a report style;

The document has been design to be a reference guide to supply chain companies and companies considering diversification into the sector; allowing the reader to “dip in” to the document for specific content, without the need to read the entire chapter or dissertation. The intention being that the reader can gain a rapid broad understanding and overview of the sector, without being overwhelmed in detail.

8.1.2 DIVERSIFICATION OPPORTUNITIES &

Objective: Identify diversification opportunities for their business.

The business opportunities presented by the MRE sector will be vast, covering many professional disciplines, opportunities to diversify will depending on the existing company’s skills, services and ability/willingness to adapt.
Chapter 5.2 of this dissertation illustrates the “Diversification Model”, the model can be used to help individual companies in identifying the opportunities specific to their business.

The “Diversification Model” is broken down into 7 key stages

1. The MRE Sector: Gain an understanding of the sector
2. Skills and Services: Gain an understanding of the skills and services required by the sector
3. Location of MRE activity: Identify existing and pipeline locations for MRE activity.
4. Transferable Assets: Identify existing skills and services in house that are required by the MRE sector.
5. Target Market: Identify Target markets, using the information gained in steps 3 and 4.
6. Competition: Identify existing business competition in chosen target market.
7. Market entry: decision to diversify.

Once all of the above steps have been completed, the potential supply chain can now make a more informed decision on diversification, it is possible having been through this process that best economic decision would be not to diversify; this will be heavily depended on transferable assets.

8.1.3 TRANSFERABLE ASSETS

Objective: Identify transferable assets or skills, utilisable by the MRE sector

When considering the business opportunities presented by the MRE sector, it will be important to identify any pre-existing skills or services which can be directly transferred into the MRE Sector.

Transferable assets offer a potential supply chain company the quickest route to market and with no additional cost to their company, with the exception of a little marketing and networking.

Chapter 5.2 of this dissertation illustrates the “Diversification Model”, which can assist a company in identifying transferable assets of their business.
8.1.4 CHALLENGES

Objective: Understand the challenges and successes faced by others working in the south west MRE sector.

Understanding the challenges faced and learnings by those companies working in the sector have been identified through the “supply chain questionnaire” which can be seen Chapter 5.3 of the dissertation.

The “supply chain questionnaire” consists of three key chapters:

1. The supply chain company questionnaire
2. The supply chain business support tools feedback form
3. The engagement organisations questionnaire.

*The supply chain company questionnaire*

The supply chain company questionnaire consisted of 17 questions, and was undertaken by 15 existing south west supply chain companies working in the MRE sector.

*The supply chain business support tools feedback form*

The supply chain business support tools feedback form, consisted of 53 identified “support tools” for supply chain companies working in the MRE sector, participants were asked to tick only those “support tools” which they found to be useful to their business. A total of 12 companies undertook this exercise.

*The engagement organisations questionnaire.*

The engagement organisations questionnaire consisted of 10 questions, and was undertaken by 5 existing MRE supply chain support organisations.

The results of the supply chain questionnaire can be seen in chapter 6 of this dissertation.
8.2 APPLICATION AND CASE STUDY

When bringing together the ‘decision to diversify model’ and the result of the ‘south west supply chain questionnaire, potential supply chain companies in the south west are enabled with the tools to identify the opportunities for their business in diversification into the sector (model) and understand the methods of engagement (questionnaire) required.

![Figure 8-1 Enablement process](image)

The recommendations given in this dissertation, guide a potential supply chain company in their decision to diversify, allowing them to identify the steps and actions required to enable successful market entry into the MRE sector.

The dissertation only provides recommendations for a potential supply chain company to enter the MRE market and does not address what market opportunities are presently available in the current MRE market.

8.3 MRE IN THE SOUTH WEST

The MRE sector as a whole in the south west still has much progress to be made in the path to commercialisation, with many south west based supply chain companies winning work outside of the south west’s geographical remit. Those companies with ability to mobiles their service and skills to any given location will be at an advantage over those who are geographical fixed.

Opportunities for companies in the south west to win MRE work in the south west are at present limited, primarily due to sector maturity (wave energy and floating wind), limited natural resources (Tidal) and project delays (offshore wind).

The south west however has demonstrated its commitment to the MRE sector and recognised the challenges faced by developers, by the creation of initiatives...
such as Fab Test, LTT and COAST; these facilities are direct responses to developer needs, being supported by local academics and authorities, while being welcomed by existing local supply chain.

The UK government has positioned the south west as a centre of excellence for MRE, through the designation of the SWMEP, and therefore there is reason to be optimistic for the future of south west supply chain winning work in the MRE sector.

8.4 FURTHER WORK

This dissertation although helpful in the ‘decision to diversify into the MRE sector’ process, falls short of identifying the exact opportunities; this is part due to the unique nature of each individual business, but is also heavily reliant on current market trends.

Currently the MRE sector as a whole is very susceptible to change and market instability.

Therefore in order to gain a true and accurate account of the real immediate opportunities to south west companies, research will be required on current market stability and pipeline projects.

This new research should focus on funding and include:

- Future work projection: which projects have secured funding and when they will begin work.
- Market leader: Which developers have secured funding
- Funding streams: what is available

At present only those with funding will be developing projects, therefore south west companies will need to work with these companies if they wish to enter the market successfully.
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# APPENDICES

## APPENDIX A: WAVE TECHNOLOGY DEVELOPER LIST

Source www.emec.org.uk

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## APPENDIX B: TIDAL TECHNOLOGY DEVELOPER LIST

Source www.emec.org.uk

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### APPENDIX C: DATABASE OF MRE SUPPLY CHAIN COMPANIES IN CORNWAL

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<td>Name: Mike Reynolds Position: Port Operations Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Consultancy/ Marine Operations</td>
<td>Name: Richard Parkinson Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Coastline Services</td>
<td>Hydrographical / Environmental</td>
<td>Name: David Hitchcock Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Duchy Hydraulics</td>
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<td>Name: David Arron Position: General Manager Email: Removed for publication Phone: Removed for publication</td>
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<td>Fugro Seacore</td>
<td>Marine Operations</td>
<td>Name: Karen Biggs Position: New Business Unit Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Drystan Jones Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Armada</td>
<td>Hydraulics</td>
<td>Name: Damon Wright Position: Sales Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: John Henderson Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Rob Maynard Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Julian Greet Position: Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Port Facilities</td>
<td>Name: Mark Killingback Position: Harbour Master Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Anne Somerville Position: General Manager Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Geoffrey Wilson Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Keith Pope Position: Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Jane Jenner Position: Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: James Williams Position: Managing Director Email: Removed for publication Phone: Removed for publication</td>
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<td>Name: Fred Buckingham Position: Director Email: Removed for publication Phone: Removed for publication</td>
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## APPENDIX D: DATABASE OF MRE SUPPLY CHAIN COMPANIES IN DEVON

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<thead>
<tr>
<th>Company Name</th>
<th>Area of Expertise</th>
<th>Personnel Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falmouth Divers</td>
<td>Marine Operations</td>
<td>Steve Roue, Managing Director</td>
</tr>
<tr>
<td>Plymouth Marine Laboratory</td>
<td>Environmental</td>
<td>Peter Hughes, Commercial Director</td>
</tr>
<tr>
<td>Manuplas</td>
<td>Manufacture</td>
<td>Steve Ward, Technical Director</td>
</tr>
<tr>
<td>Seawind</td>
<td>Civil Engineers / Marine Operations</td>
<td>Gary Duff, Projects Director</td>
</tr>
<tr>
<td>Marine Energy Matters</td>
<td>Consultancy</td>
<td>Colin Cornish, Managing Director</td>
</tr>
<tr>
<td>Supercat</td>
<td>Consultancy</td>
<td>Nick Ames, Managing Director</td>
</tr>
<tr>
<td>J&amp;S</td>
<td>Consultancy / Manufacture / Marine Operations</td>
<td>Chris Napier, General Manager Marine Renewables</td>
</tr>
<tr>
<td>Fraser Nash Consultant</td>
<td>Consultancy</td>
<td>Martin Concannon, Business Manager</td>
</tr>
<tr>
<td>KML</td>
<td>Marine Operations</td>
<td>Diccon Rogers, Managing Director</td>
</tr>
<tr>
<td>Halcrow</td>
<td>Consultancy / Marine Operations</td>
<td>Rachel Jordan, Associate Director</td>
</tr>
<tr>
<td>RPS Energy</td>
<td>Support Service</td>
<td>Andrew Stenson, Senior Project Manager</td>
</tr>
<tr>
<td>Ocean Electric Power</td>
<td>Support Service</td>
<td>Barry Gamble, Chairman</td>
</tr>
<tr>
<td>Babcock Marine</td>
<td>Port Facilities</td>
<td>John Howie, Managing Director</td>
</tr>
<tr>
<td>ADPS</td>
<td>Vessels / Marine Operations</td>
<td>Lee Brown, Technical Director</td>
</tr>
<tr>
<td>Environ</td>
<td>Environmental</td>
<td>Johanna Curran, Senior Manager</td>
</tr>
<tr>
<td>WSP Environmental &amp; Energy</td>
<td>Environmental</td>
<td>Andrew Bright, Divisional Director</td>
</tr>
</tbody>
</table>
APPENDIX E: DATABASE OF UK ORGANISATIONS ENGAGED WITH MRE SUPPLY CHAIN COMPANIES

<table>
<thead>
<tr>
<th>Group Or Organisation</th>
<th>Name</th>
<th>Company Position</th>
<th>email</th>
<th>Phone number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable UK</td>
<td>David Krohn</td>
<td>Wave and Tidal Energy Development Manager</td>
<td>Removed for publication</td>
<td>Removed for publication</td>
</tr>
<tr>
<td>Regen South West</td>
<td>Johnny Gowdy</td>
<td>Programme Director</td>
<td>Removed for publication</td>
<td>Removed for publication</td>
</tr>
<tr>
<td>The MOR Group</td>
<td>Steve Roue</td>
<td>Chairman</td>
<td>Removed for publication</td>
<td>Removed for publication</td>
</tr>
<tr>
<td>Cornwall Marine Network</td>
<td>Tim Bowerbank</td>
<td>Marketing Manager</td>
<td>Removed for publication</td>
<td>Removed for publication</td>
</tr>
<tr>
<td>Invest in Cornwall</td>
<td>Mandy Feldon</td>
<td>Marketing &amp; International Business Development</td>
<td>Removed for publication</td>
<td>Removed for publication</td>
</tr>
</tbody>
</table>
Supply Chain Businesses Questionnaire

Interview name:

Company:

Company position:

Date:

SECTION 1: QUALIFYING

1. Has your company ever worked or won work in the MRE sector?
   • Yes (go to Q3)
   • No (go to Q2)

2. Does your company have aspirations to work in the MRE sector?
   • Yes (go to Q5)
   • No (Terminate interview)

3. How long has your business been working in the MRE sector?
   • Less than 1 year
   • Less than 5 years
   • Over 5 years

4. As a percentage how much of your company turnover is generated from work in MRE sector?
   • Less than 25%
   • 25-50%
   • 50– 75%
   • Over 75%
5. What technology sectors are you working or hope to work in?
   - Offshore wind
   - Wave
   - Tidal
   - Floating wind

SECTION 2: UNDERSTANDING THE OPPORTUNITY

6. Trigger: Reflecting on your decision to enter the MRE market; what was the initial trigger that prompted you to investigate opportunities in the industry further.
   - Prompts: Television program, Word of mouth, Trade magazine/paper, Funding opportunity, Collaboration opportunity, Event, Job opportunity.

7. Decision: Once initially interested what steps did you take to understand the market, to allow you to identify potential opportunities for your business?
   - Prompts: Political analysis, Economic analysis, Social analysis, Technological analysis, Customer needs, Market analysis, Assessment of skills within your business, Funding & grant analysis, Training, association memberships, reports.

7.2 Who undertook this work?
   - Myself
   - Internal member of staff
   - External consultant
8. Assisting Decision making: Reflecting on your decision to enter the MRE sector, what market analysis would have been useful to you in the decision making process?

- Prompts: Political analysis, Economic analysis, Social analysis, Technological analysis, Customer needs, Market analysis, Assessment of skills within your business, Funding & grant analysis

8.2 How would you like to receive this information?

- Prompts: Presentation/Event, Report, Dedicated website

8.3 Would you have been prepared to pay for this information?

- No, It should be free
- Yes, but it would need to be reasonably priced
- Yes I would pay to receive this information.

SECTION 3: MARKET ENTRY

9. First Activity: Thinking back to your initial experiences in the industry, what were the first activities you undertook to support your market entry?

- Prompts: Marketing & Advertising, Further market research, SWOT, Recruitment, Attended MRE events & conferences, exhibited at an MRE event, Joined trade association (local/national)

9.2 Who undertook this work?

- Myself
- Internal member of staff
- External consultant
10. New product or service development: What (if any) new product or service development was required in your diversification/entry into the sector?

- Prompts: Idea generation, Concept testing, Brand development, Financial feasibility, Sales forecasting, Training & courses (what courses/qualifications?).

10.2 What support would you like to see for new product or service development?

- Prompts: Funding, Mentoring, Access to equipment/facilities

10.3 How would you like to see this support delivered?

- Prompts: Funding, Mentoring, presentations, reports, dedicated company, dedicated website.

11. Communication: When thinking about initial market entry what methods of market communication did you undertake or find useful to your businesses.

- Prompt: conferences & exhibitions, Trade magazines & newspapers, Funding & collaboration opportunities (e.g. TSB, KTP), Expert assistance (on market entry), Meeting Developers, Meeting utility company representatives, Local councils and inward investment companies, advertising and marketing companies, networking.

11.2 Who undertook this work?

- Myself
- Internal member of staff
- External consultant.

11.3 Of these which was the most useful
12. Supporting market entry: What support would you like to see for businesses wishing to enter the MRE market entry?
- Prompt: what would you have found useful? Funding, Assistance in marketing, Reports on industry language or jargon

12.2 How do you thank this could best be delivered?

SECTION 4: BARRIERS TO ENTER MARKET

13. Barriers experienced: During your company’s transition into the sector what barriers did you experience which delayed or limited your market entry success?
- Prompt: What slowed you down was expensive. Hard or difficult, simply impossible, lost you work.

13.2 Thinking about these barriers, how best do you think they could be overcome?

SECTION 5: BARRIERS TO BUSINESS GROWTH

14. Preventions to growth: Thinking now about your business today; what are the barriers preventing your MRE business to grow?
- Prompt: Are there any services or products you are prevented from delivering? What stops your business winning more MRE work? Lack of human resource (recruitment/training), Equipment, Facilities, Software, Turnover, Non-disclosure agreements (NDA’s), Poor communication, Lack of industry demand, Location, Competition, Sporadic work
15. Supporting business growth: What support does your business require to grow its MRE activities?
   - Prompt: training? What courses/qualifications? What would help you win more business?

15.2 How would you like this support to be delivered?

SECTION 6: RECOMMENDATIONS

16. Learning's: What would you do differently if you were entering the market today?

17. Recommendations: What key recommendations would you make for a fellow business deciding to enter the MRE market?
APPENDIX G: THE SUPPLY CHAIN BUSINESSES SUPPORT TOOLS FEEDBACK FORM TEMPLATE

**Toolbox Tick List**

Based on your experience of the sector, could you please tick the following ‘Industry Tools’ which you have found or would find useful to your MRE business?

There will be space at the bottom of this document if you have any further comments. If you have further comment relating specifically to a question please clearly label with relevant question number.

**Thinking about events**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Meet the Buyer events</td>
</tr>
<tr>
<td>2.</td>
<td>Meet the supplier events</td>
</tr>
<tr>
<td>3.</td>
<td>Sharing exhibition space with other MRE supply chain companies</td>
</tr>
<tr>
<td>4.</td>
<td>Local MRE conferences</td>
</tr>
<tr>
<td>5.</td>
<td>Local MRE exhibitions</td>
</tr>
<tr>
<td>6.</td>
<td>Local industry representation presenting at national industry events</td>
</tr>
<tr>
<td>7.</td>
<td>Grants to exhibit at industry conferences</td>
</tr>
<tr>
<td>8.</td>
<td>Grants to attend industry conferences</td>
</tr>
<tr>
<td>9.</td>
<td>Grants for marketing material (graphics, stands, brochure, leaflets)</td>
</tr>
<tr>
<td>10.</td>
<td>Organised meetings at conferences (UKTI, Inward investment)</td>
</tr>
<tr>
<td>11.</td>
<td>Journalist days - Inviting a group of journalist to SW to showcase MRE.</td>
</tr>
<tr>
<td>12.</td>
<td>Overseas trade mission - Group of companies exhibiting at international events</td>
</tr>
<tr>
<td>13.</td>
<td>Business exchange - Group of companies touring to meet with key suppliers</td>
</tr>
</tbody>
</table>
### Thinking about the web

| 14. | Support and advice for the Web |
| 15. | Grants for web design |
| 16. | A dedicated industry website |
| 17. | Video's showcasing SW MRE offer |
| 18. | Dedicated MRE social media outlets (linked in, twitter, you tube) |
| 19. | Social media management (updating social media outlets) |
| 20. | Free MRE image bank |
| 21. | Web based advertising |
| 22. | Online business planning tools |
| 23. | Web based shared areas |
| 24. | Messaging service for SW MRE companies |
| 25. | MRE tender alerts |
| 26. | MRE news alerts |

### Thinking about media

| 27. | MRE supply chain catalogue/directory |
| 28. | Press releases |
| 29. | Arranged media liaison |
| 30. | Industry awards |
| 31. | Magazine |
| 32. | Newsletter |

### Thinking about sales

| 33. | Sales training |
| 34. | Business advice |
| 35. | Business intelligence (database of MRE contacts) |
| 36. | Access to meeting rooms |

### Thinking about finance

| 37. | Grants for capital expenditure |
| 38. | Cheap loans for capital expenditure |
| 39. | Grants for sales training |
| 40. | Grants for marketing |
| 41. | Grants for prototyping |
| 42. | Grants for collaboration |
| 43. | Grants for to attract developers to SW |
**Thinking about access**

44. Free/cheap access to equipment  
45. Free/cheap access to facilities  
46. Free/cheap access to knowledge (academics, research, reports)

**Thinking about training and qualifications**

47. Grants for MRE training  
48. Grants for MRE qualifications & certification  
49. Locally run MRE qualifications & certification

Finally do you think it would be a good idea to create the following tools which were specifically designed for the South West marine energy industry?

50. Dedicated SW MRE Website  
51. Dedicated SW MRE Magazine  
52. Dedicated SW MRE Newsletter  
53. Dedicated SW MRE Conference & Exhibition

*Thank you for your participation*
APPENDIX H: THE ENGAGEMENT ORGANISATIONS QUESTIONNAIRE TEMPLATE

UK Organisations Engaged With MRE Supply Chain Companies Questionnaire

Interview name:
Organisation:
Organisation position:
Date:

SECTION 1: QUALIFYING

1. Does your organisation engage with MRE supply chain companies?
   • Yes
   • No (Terminate questionnaire)

2. How long has your organisation been engaging with MRE supply chain companies?
   • Less than 1 year
   • Less than 5 years
   • Over 5 years

3. As a percentage how much of your organisation’s activity is based around the MRE Sector?
   • Up to 15 %
   • 15 – 30%
   • 30 - 50%
   • More 50%
4. What MRE technology sectors does your organisation engage with?
   - Offshore wind
   - Wave
   - Tidal
   - Floating wind

SECTION 2: UNDERSTANDING YOUR ENGAGEMENT WITH THE MRE SUPPLY CHAIN SECTOR.

5. What activities has your organisation undertaken to engage with MRE supply chain companies?
   - Prompt: conferences, exhibitions & networking events, Trade magazines & newspapers, Funding & collaboration opportunities, Expert assistance (on market entry), Meeting Developers, advertising & marketing, breakfast meetings, workshops.

6. How does your organisation encourage businesses to diversify into the MRE sector?
   - Prompt: events, advertising, mentoring, 1:1 advice & recommendations, media & PR, reports, funding, collaboration opportunities.

7. What would make it easier for your organisation to engage with the MRE supply chain?
   - Prompt: dedicated team for MRE SC engagement, dedicated point of contact for MRE SC, fuller understanding of what SC companies need/want, Funding.
8. How does your organisation support the growth of MRE supply chain businesses?

- Prompt: promotes tendering opportunities, promotes collaboration opportunities, assisting SC in accessing funding (for training, new product development, capital investment), engaging with enablers (e.g. CE, MMO)

9. What barriers have you experienced when attempting to engage with the MRE supply chain?

- Prompt: lack of interest, lack of understanding in what I can offer, difficulty in spreading core message & assistance, difficult to organise joint availability.

10. In your opinion what support should be made available to encourage businesses to diversify into the MRE sector?

- Prompt: funding, low cost loans, grants, education (events, reports) on what the real market opportunities are.