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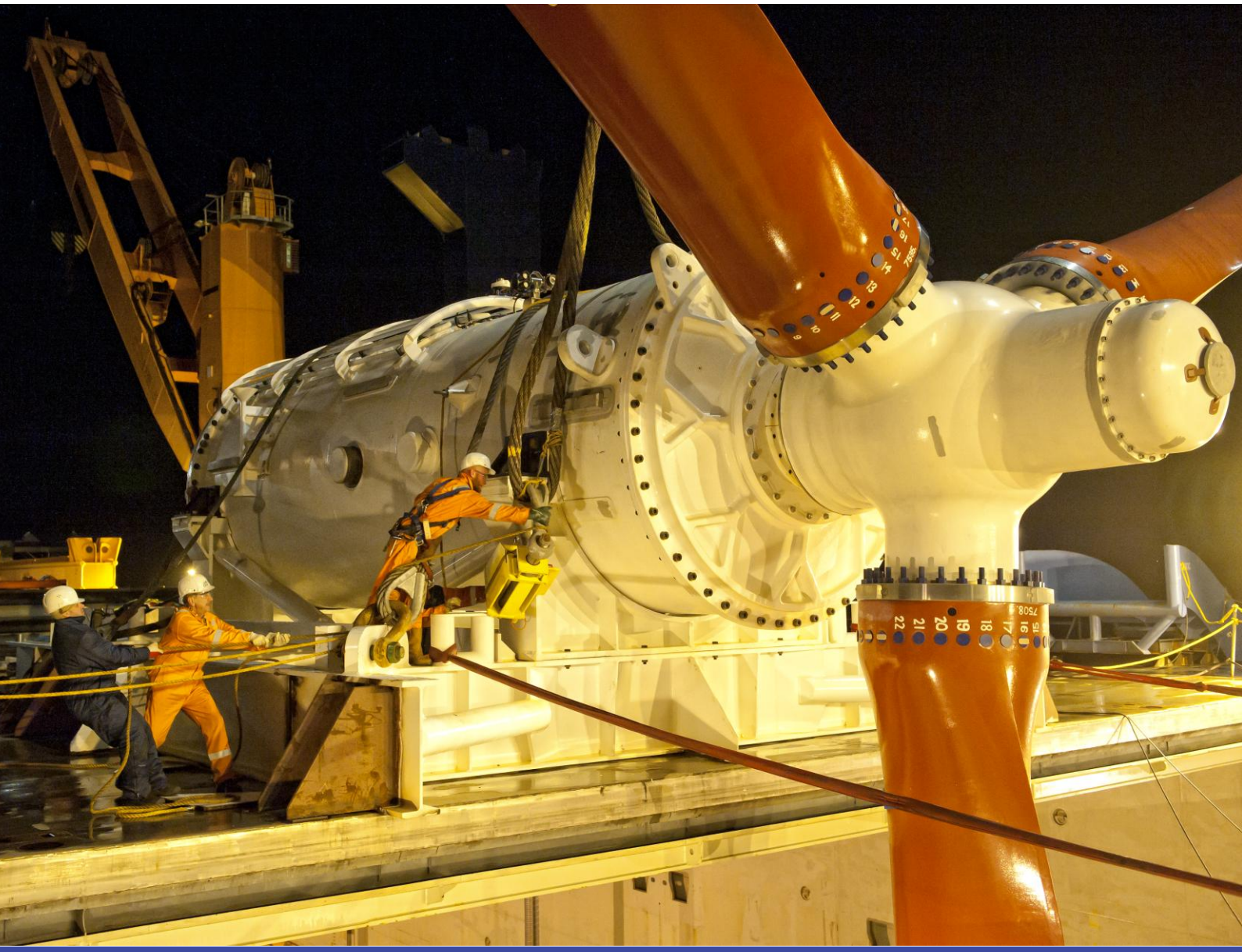

Wave and Tidal Supply Chain Development Plan:

Supply chain capability and enabling action recommendations

February 2015

BVG Associates

BVG Associates is an independent consultancy with a global outlook, specialising in wind and marine energy generation systems. We deliver market and economic analysis, business and supply chain development, and technical innovation. Our team has over 140 years of experience and the best objective market and supply chain knowledge for wind turbines in the UK.

Our client base spans Government, enabling bodies, turbine manufacturers, developers and investors and the entire supply chain.

We add value by de-risking major decisions and increasing the return our clients see from the time and money that they are investing in wind and marine energy.

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1. Introduction

The development of the wave and tidal energy industries represents a significant opportunity for the UK. The wave energy industry in Scotland is currently leading the world in device development and installation and, although we see other nations catching up, the UK tidal sector as a whole remains in pole position. Scottish Enterprise (SE) estimated that the total spend on wave and tidal energy systems in Europe for the period from 2014 to 2030 will be over £15 billion[1]. Over 80% of this will be on device manufacture, balance of plant and installation.

The wave and tidal sectors have, though, been weakened in the UK in the last quarter of 2014 by Siemens putting Marine Current Turbines up for sale to exit the sector, by Pelamis entering receivership with no buyer being found, and by job cuts at Aquamarine Power. In the same period, the Scottish Government has set up Wave Energy Scotland to focus on collaborative work to develop critical components, optimal technology selection and cost reduction.

It is important that UK suppliers do not miss the opportunity to build up experience, skills and capacity so that they stay ahead in the race to deliver to potential global markets. The supply chain needs to follow the pattern seen in other countries in other sectors, rather than the pattern of offshore wind in the UK where the experience of supplying to projects of companies in Germany and Denmark has been an obstacle to the growth of a significant UK supply chain. The potential for UK success can be seen in the oil and gas sector. In 2012-13 the supply chain to the oil and gas sector in Scotland achieved international sales of £10 billion, a growth of 22% from the previous year[2].

The wave and tidal sectors, however, face a tough battle to respond to the recent problems and reduce cost of energy quickly enough to establish themselves as credible players in the decarbonised energy mix. Again, these challenges are not unique and lessons can be learnt from elsewhere to maximise the chance of making this transition.

RenewableUK and Scottish Renewables (SR) commissioned BVG Associates to produce this report. Its purpose is to identify strengths and weaknesses in the UK supply chain and suggest interventions which could be taken by industry and government to grow value-creating, sustainable and confident sectors. This report builds on the Marine Energy Programme Board (MEPB) report *Maximising the Value of Marine Energy to the United Kingdom* published in February 2014.

The recommendations for support of the UK supply chain were identified through a process of assessing the current status of the supply chain as a whole, as well as the UK in particular and sharing significant discussion of potential interventions with industry. It is clear that actions need to be implemented quickly and consistently if the opportunities for the sectors are to not to be lost.

[1] *Manufacturing and beyond: realising the supply chain opportunity*, Scottish Enterprise, 2014, available online at www.scottishrenewables.com/media/uploads/seonaid_vass,_scottish_enterprise.pdf, last accessed January 2015.

[2] *Survey of international activity in the oil and gas sector 2012/13*, Scottish Enterprise, 2014, available online at www.scottish-enterprise.com/knowledge-hub/articles/insight/scottish-oil-and-gas-exports-reach-10-billion?intcmp=hp08-2014wk20, last accessed January 2015.

2. Methodology

The project was split into three stages.

Phase 1: Literature review and aide memoire development

The steering group for this work was the MEPB's Economic Benefits subgroup. This group is comprised of knowledgeable stakeholders and the most active players in wave and tidal energy, including device manufacturers, project developers, supply chain companies, utilities, development agencies, trade associations and Government. This group compiled a list of existing and recent support programmes available to the wave and tidal energy supply chains as well as a list of relevant enabling bodies.

BVGA added to these lists based on in-house knowledge and research into other sectors such as the Danish onshore wind sector, the UK offshore wind sector and the UK automotive, defence, nuclear and oil and gas sectors.

BVGA then looked at the relevance and the effectiveness of initiatives undertaken within these programmes to support the wave, tidal and other relevant sectors. Based on this review, and in discussion with the steering group, BVGA developed a list of support initiatives likely to be most effective in supporting the wave and tidal energy sectors.

Based on the supply chain support initiatives identified in the literature review and the sub-elements agreed with the steering group for the UK supply chain capability assessment, an aide memoire was developed to structure engagement and then agreed with the steering group. This is presented in Appendix 2 and included gathering views on:

- The influence of the support initiatives identified, and
- The capabilities of the areas of the UK supply chain most relevant to the interviewee.

For use in Phase 2, BVGA developed a target list of organisations to engage with. This list was agreed with the steering group before the start of Phase 2. A wider list of suppliers was identified by the steering group to be consulted via an online survey in addition to the interviews conducted by BVGA, thereby ensuring industry-wide engagement.

Phase 2: Assessing views on supply chain support initiatives and supply chain capability

BVGA assessed views on supply chain initiatives under four headings:

- Market conditions support initiatives
- Innovation support initiatives for supply chain companies
- Financial support initiatives for supply chain companies, and
- Business development support for supply chain companies.

It assessed the UK supply chain capability across 12 sub-elements:

- Wave/tidal farm design, development, ownership & management
- Wave energy devices and subsystems
- Tidal energy devices and subsystems
- Foundation and mooring systems
- Subsea array and export cable
- Substation electrical systems
- Installation ports
- Foundation and device installation
- Subsea cable installation
- Smaller vessels and equipment (for personnel & small component transfer)
- Larger vessels (with lifting capability), and
- Consultancy and R&D services.

The aide memoire was used to guide 26 one-to-one interviews with organisations on BVGA's target list, as listed in Appendix 3. These included three interviews with large players that have not yet committed to supply to the sectors. Interviewees engaged under the agreement that that the content would only be shared with RenewableUK and SR, and would not be published.

Volume predictions used in the discussion were based on the MEPB's 2013 "current support scenario" forecast of 121MW of UK wave and tidal energy in operation by 2020.

The results of the interviews were analysed and summarised in table format suitable for publication.

In parallel, RenewableUK undertook direct engagement with the wider list of companies via an internet survey.

For peer review, the results of the study were also presented to and discussed with the steering group.

Phase 3: Recommended actions

Following discussions with the steering group, a list of prioritised recommended actions was agreed.

3. Review of initiatives from across multiple sectors

3.1. Sources of data

In Phase 1, BVGA identified and reviewed cross-sector or sector specific supply chain development programmes that have been used in the UK. In particular, we looked at programmes from the aerospace/defence, automotive, nuclear, oil and gas and offshore and onshore wind energy sectors.

Sources of information included the following key documents:

- *Growing the Automotive Supply Chain: The Road Forward* (Automotive Council UK, 2011, update 2012)
- *Offshore Wind Cost Reduction Pathways Study* (The Crown Estate, 2011)
- *Offshore Wind Industrial Strategy* (The Department for Business, Innovation and Skills (BIS), 2013)
- *Strengthening UK Based Supply Chains: Construction and Infrastructure* (UK Government, 2012)
- *Strengthening UK supply chains: Good practice from industry and government* (BIS, 2014)
- *The Nuclear Supply Chain Action Plan* (HM Government, 2012)

A full list of programmes identified is shown in Appendix 1.

In addition, we engaged with relevant people in the onshore and offshore wind and the aerospace/defence sectors to gather their views on which programmes and which initiatives within those programmes worked well and which worked less well in their experience.

During the literature review, BVGA identified an extensive range of initiatives that have been used across industries in order to promote the development of UK supply chains. These initiatives were categorised into four groups as noted above and these are discussed in the following sub-sections.

The hypothesis of this phase of the study was that the wave and tidal sectors may be able to benefit from implementation of initiatives first used in other sectors. In fact, we have established that many ways that other sectors have been supported or help themselves are already being implemented in the wave and tidal sectors, or simply are not relevant due to the differences in scale of different sectors. This is at the same time both assuring (the sectors are in touch enough with what is helping elsewhere) and disappointing (as we have not uncovered any significant new ways to make a difference).

3.2. Market conditions support

Market conditions support initiatives are defined as those aimed at supporting the development of a sector as a whole, through the provision of investment, policies and/or information.

In any sector, investors need confidence in future growth and revenue, underpinned by regulatory stability.

Companies are looking for returns on their investment comparable to other UK sectors, taking into account relative risks. This is particularly challenging for companies looking to diversify from the oil and gas and defence sectors, where margins are historically much higher and more consistent than those that are likely to be achieved in the mid-term in the wave and tidal sectors.

Visibility of future market growth is required to understand the timetable of opportunities. Typically these come from market forecasts and demand roadmaps, either issued by trade bodies (with a vested interest in the sector) or government. A good example is *Project Pathways*, a Department of Energy and Climate Change (DECC) led initiative, which provides the oil and gas sector with information on future projects within the industry. The impact of such initiatives depends on confidence in the information provided that can take significant time to establish. Most organisations active in a sector will also commission internal or external assessments of future markets, focussed on their specific role in a sector. We found significant scepticism in the forecasts provided for the wave and tidal sectors, as they have been seen by some as over-politicised at times.

Direct market support initiatives aimed at creating a sustainable market are highly sector specific. Within the renewable energy sector, the government's Electricity Market Reform, was designed to provide positive, stable conditions for the UK renewables sector whilst capping the financial exposure of the taxpayer/consumer. The period of transition from the Renewable Obligation Certificates (ROCs) regime to the Contracts for Difference regime (CfD) has now begun. The strike price for both wave and tidal generation is £305/MWh with no reduction in price before 2020. This is only available for the first 30MW of any given project, however, and for the first 100MW across all projects to gain a contract. Uncertainty remains beyond the first 100MW installed and past 2020. In contrast, EDF has been granted an index-linked strike price for the nuclear plant at Hinkley Point, payable for 35 years.

Market support initiatives were identified as the key driver for the Danish onshore wind sector and its growth in the 1980s and 1990s. This included consistent government commitment to onshore wind over a period now approaching 40 years, backed-up by over £1 billion of investment in grid infrastructure, R&D and subsidies for energy production. These market support initiatives helped establish Denmark as a leading market and position Danish suppliers well for significant export opportunities. Two of the top 5 global wind turbine manufacturers today are based in Denmark, despite the fact that Denmark has a small industrial base and now has slipped to having only

the 6th largest installed wind capacity in Europe. Critical to the establishment of the supply chain was the Danish Government's support for export, especially via overseas development and export credit arrangements. A similar strategy was implemented in Germany, with a similar result. Starting with a much larger industrial base, the industrial impact has been much larger. One difference is that although Germany acted after Denmark, it has continued to support a home market which remains comfortably the largest in Europe, despite not having a particularly good wind resource, hence meaning a relatively high cost of energy from the wind energy sector. It is understood that its strategy remains in place partly to support its supply chain which provides significant tax revenue and balance of payment benefits and partly in response to climate change. Fundamental to the German supply chain success has been market and revenue confidence and significant export support.

In Spain, there are again strong parallels, with an additional element of policies supporting local supply, including at a regional level. Although many saw this as anti-competitive, the strategy lasted for a considerable time and had a significant impact.

During this period of activity on the continent, the UK government also provided R&D and market support, but the home supply base that has established is very much smaller. The drivers for this are important to note:

- The market generally happened later or at a smaller scale, meaning that there was less incentive for a local supply chain to establish in the face of established continental competition.
- Market revenues were less certain, meaning that there was less confidence to invest.
- There was negligible support for export, meaning that UK companies struggled to access any more than their home market.

In summary, during the literature review, our engagement with others sectors and from the steering group inputs, we identified the following areas where supply chain initiatives are likely to be most effective for the wave and tidal sectors:

- Strong and consistent signals of support from UK and devolved governments
- An attractive strike price (or other revenue support), and
- Provision of visibility/predictability as to size of market.

These areas, seen as critical in other sectors are all already high on the agenda in the wave and tidal sectors.

3.3. Innovation support

Innovation support initiatives for supply chain companies are defined as those that help the supply chain innovate and develop their technology towards commercialisation. Initiatives include provision of advice and funding. For this report, we have focused on innovation support for the progression of new technology from development (technology readiness level (TRL) 4) onwards. This range is selected because it is unlikely that innovations at an earlier stage will have impact in the wave and tidal market within the short-medium term.

There is a large range of innovation support available in the UK for many sectors, driven by key organisations such as DECC, the Energy Technologies Institute (ETI), Innovate UK (formerly Technology Strategy Board (TSB)), the Offshore Renewable Energy (ORE) Catapult and SE, some incorporating access to senior industry decision makers and end users to help maximise the value of funding and uptake of innovations by informing and steering development work. The amount available to each sector varies, and the wave and tidal sectors have consumed only a small proportion to date.

Public funding is widely used across most technology driven sectors to support innovation. A large range of example schemes was identified. Innovation funding is often tied into collaborative programmes in order to ensure knowledge exchange and support innovation throughout the supply chain. Collaborative R&D centres have also provided successful forums for the stimulation of collaboration between supply chain elements in the UK. These types of centres are extensively used within the aerospace sector, and good examples of thriving centres that are impacting the UK supply chain include The National Composites Centre (NCC) and the Advance Manufacturing Research Centre (AMRC) which together now form part of the High Value Manufacturing Catapult. A number of these centres also provide accessible testing facilities which are available for use by all, including the wave and tidal sectors. One of the strengths of this type of centre is the opportunity for lower tier suppliers to access higher tier suppliers and end users and work directly with them to understand their needs. They also provide an independent forum in which to address cross industry challenges.

For companies in the supply chain, there are challenges in accessing funding due to the significant effort required to bid for and win funding and then provide required information during the project, though many programmes are now far more industry-friendly in this respect than in the past. We were advised of the reality of this barrier by both small and large players. Collaboration also is not beneficial in all cases. Under some circumstances it can lead to inflexible project structures and complicated routes to exploitation of the output of the research due to, for example, joint ownership or disputes over any arising intellectual property (IP).

Automotive engineering companies such as Ricardo and Romax, have made significant successful use of R&D funding from programmes including DECC, ERDF, EU

FP5-FP7, Innovate UK, RGF and to develop and transition their technologies to new sectors and also build relationships with target customers in collaborative projects. In particular, Romax has used R&D funding to develop its entry to the wind drivetrain engineering market, while Ricardo has developed hybrid and electric vehicle technologies in this way. Both companies have enjoyed significant growth in both sales and expertise through their R&D activities.

Industry technology roadmaps are used in most sectors to steer support mechanism strategies and ensure that innovation within the supply chain is aligned to the intended direction of progress. Examples of industry technology roadmaps are included in the *Offshore Wind Cost Reduction Pathways Study*, published by The Crown Estate in 2012, the *Offshore Wind Industrial Strategy*, published by BIS in 2013, and the *Automotive Technology Roadmap* produced by the Automotive Council in 2013.

The complexity of UK R&D funding landscape is also identified as a potential barrier to its efficient use. This is illustrated in Figure 1 which shows the headline sources and destinations of R&D funding in the UK in 2011.

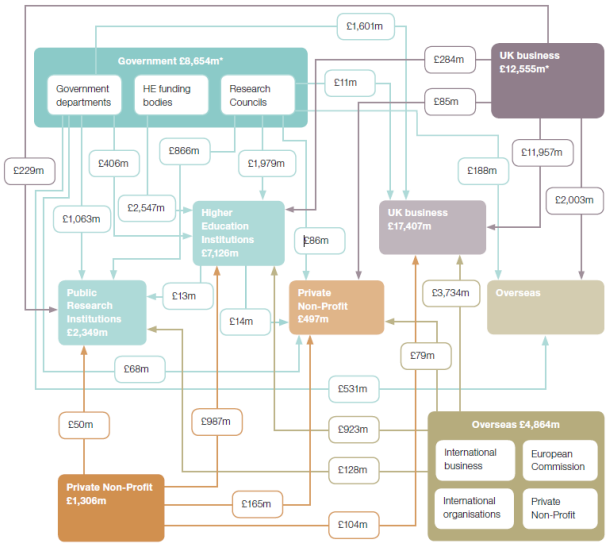

Figure 1 UK R&D funding flows in 2011 (source: *Research and Development funding for science and technology in the UK,* National Audit Office 2013)

Investment has been made in supporting innovation in the wave and tidal sectors in the UK. This has included funding and development of demonstration sites such as the European Marine Energy Centre (EMEC), Wave Hub and testing facilities such as Nautilus, the ORE Catapult's 3 MW drive train testing rig in Blyth.

Funding for R&D projects has also been made available through a number of schemes such as the Marine Energy Accelerator programme from the Carbon Trust and ORE Catapult and their current joint programme, the Marine Farm Accelerator. Additional significant funding initiatives have been put in place by organisations such as DECC, ETI and SE for supporting the deployment of large scale prototypes and pilot arrays. These initiatives include the SE wave and tidal energy support (WATERS) fund. Work has also been carried out to ensure there is a strong road map for technology development and deployment. Two recent examples are the *Marine Energy Technology Roadmap 2014,* published by ETI and UK Energy Research Council (UKERC) and the relevant sections of SI Ocean's *Wave and Tidal Energy Market Deployment Strategy for Europe,* published in 2014. Work is currently underway to bring the DECC *Technology Innovation Needs Assessment* for wave and tidal energy up to date.

To date these UK funding initiatives in the wave and tidal sectors have had mixed success. Uptake on some programmes has been lower than anticipated. This has been partially due to lack of availability of industry matched funding due to uncertainty in the sectors' futures.

Funding is also available from European Community (EC) level initiatives. Historically, the sectors have been supported by the FP7 framework, both directly and through programmes such as the 'Research for the benefit of SMEs' programme, which provides Small and medium-sized enterprises (SMEs) access to external researchers. Currently, the Horizon 2020 programme is available to support the wave and tidal sector. There is a perception that Horizon 2020 is better suited to the sector than FP7. In 2014, the UK renewables sector, however, has not been particularly successful in bringing together strong consortia and compelling project scopes to secure Horizon 2020 funding compared to organisations in other EC countries. There is potential for better support for UK companies and enablers to make a difference here.

The outcome of innovation support to the wave and tidal sectors to date can be summarised as follows:

Tidal: good success, with continuous large scale generation to grid achieved from a small number of technology suppliers who are now ready to move to array scale demonstration projects. In part, this has been enabled by the similarity of device architecture and technology to wind turbines, and the associated transfer of experience within suppliers to both sectors.

Wave: success has been limited by the device architecture being very different from existing technologies, and by the consequential wide range of technologies being investigated. It has been a struggle to demonstrate reliable performance at scale.

From this review of innovation support in the wave and tidal and other sectors, and from the steering group inputs, it is suggested that the areas where initiatives are likely to be most effective in supporting the wave and tidal energy sectors are:

- Development of clear technology roadmaps
- External R&D programme funding (ideally single company grant funding, but consortium funding is also seen as beneficial)
- Funding for and access to array demonstration sites and testing facilities, and
- Increasing collaborative R&D/access to external competence.

Again, there are no particularly new lessons in this area to learn from other sectors, but there is certainly room for improving the effectiveness of support provided.

3.4. Financial support

Financial support initiatives for supply chain companies are defined as those that help the operations or reduce the risk for companies operating in the sector. They include direct funding as well as loans and underwriting, but exclude financial support covered under the other three sections.

A range of mechanisms have been used to provide financial support to UK supply chain companies across different sectors. Many of these have been developed for more mature industries, however, there are some strong examples that have relevance to the wave and tidal sectors.

Infrastructure grants have been used successfully across a range of markets including the offshore wind sector. Grants secured by Hull City and East Riding Councils and the Humber Local Enterprise Partnership (LEP), under BIS' Regional Growth Fund (RGF) fund, have been highly influential in ensuring Siemens' commitment to large scale manufacturing and assembly of offshore wind turbines in the region, in competition with similar offerings from overseas.

Support for finance bonds has also been used in order to support the growth of a native supply chain for some sectors such as defence, power generation and petro-chemicals. A good example of this is the Tees Valley Catalyst Fund, which was established by the Tees Valley LEP, and provides up to £4million short term loans to fund performance or warranty bonds to companies across multiple sectors. To date, funding has gone to companies in the oil and gas and petrochemicals sectors. The UK government has recently launched its debt guarantee scheme for major infrastructure projects, and this has so far underwritten £75m of loans to Drax power station for a project to convert to burning biomass, covering 33% of the project costs.

Other initiatives aim to address the lack of expertise in sector specific issues within the finance community as this can inhibit investment or access to credit. In order to address this issue, the automotive sector established an automotive joint industry forum, a collaboration between the Automotive Council and the British Bankers Association. A similar group, the Aerospace Finance Forum, was established by the aerospace sector. In the UK, the Green Investment Bank has a key role to play in building investor confidence in renewable energy and green infrastructure investments. It provides leadership to the financial community in assessing financial risk, providing confidence for other less technically focused investors to engage in the sector. It is not currently active in the wave and tidal sectors but is looking at opportunities.

In the wave and tidal sectors, a number of initiatives have been established to provide financial support. These have primarily focused on grant support for initial commercial arrays deployed in UK waters such as:

- The current Renewable Energy Investment Fund, established by SE
- The Wave and Tidal Programme: Investment in first array projects, issued by The Crown Estate, and
- DECC's Marine Energy Array Demonstrators fund (MEAD) in 2012.

There has also been direct public investment in some wave and tidal companies, such as the investment in Aquamarine Power by the Scottish Venture and Co-investment Fund and infrastructure grants for portside development around Northern Scotland.

From this review of financial support across various relevant sectors and input from the steering group, it is suggested that the areas in which initiatives are likely to be most effective in supporting the wave and tidal energy sectors are:

- Provision of access to working capital
- Direct public investment in companies
- Financing performance bonds/underwriting of contracts
- Increasing bank and investor understanding of the technology and market
- Infrastructure grants
- Tax incentives for investment, and
- Underwriting of loans.

Once again, there is little of great surprise here, but there are certainly opportunities to 'raise the game' in the wave and tidal sectors in a number of these areas. Priorities for this are established through industry engagement, discussed in Section 4.

3.5. Business development support

For the purpose of this report, business development support includes provision of expert advice or training on growing business activities for companies within their core sectors or assistance in entering new sectors. Both sector-specific and cross-sector business development support is available for companies in the UK.

Both the Manufacturing Advisory Service (MAS) and the Scottish Manufacturing Advisory Service (SMAS) are well respected programmes that provide business and manufacturing strategy support to companies across a wide range of sectors. There are a range of more sector-specific business support initiatives. For offshore wind, this includes programs such as the SE Offshore Wind Expert Support Programme and GROW: Offshore Wind, both of which provide support to UK businesses looking to develop their activities in the sector. Similar programs are run by other sectors such as the North West Automobile Alliance Business Excellence program which supports automotive companies in its region.

In offshore wind, the requirement by DECC for developers to have an approved supply chain plan is driving them to look closely at their procurement practices and local content, and commit to ways to improve both during delivery of the projects they are applying for. While it is only a new initiative, it already appears to be driving the desired behaviour in terms of development of more competitive local supply chains and increased focus on innovation and skills development. Also recently agreed by government and industry is a standard methodology, developed by BVGA, for assessing and communicating UK content in offshore wind. Such a methodology could easily be transposed to apply to the wave and tidal sectors.

Customer-led procurement agreements and practices are being implemented in many areas, including via the Nuclear Decommissioning Authority and offshore wind developers (through their recent supply chain plans). In these, the (typically large) end-customer requires that its own procurement good practice, as embedded in terms and conditions of purchase, is passed down to lower tiers of the supply chain.

The literature review for this report did not identify any significant wave- and tidal-specific business development support programmes, however some pan-industry services, such as MAS and SMAS are relevant and have been used by companies in the sectors. SE is currently developing a specific wave and tidal entry programme, similar to its Offshore Wind Expert Support Programme, for launch in 2015.

Companies receiving funding from DECC's Entrepreneurs fund also receive business development support. The scheme provides incubation support such as assistance with commercialisation and marketing plans, IP and fund raising support. This programme has been used by companies in the wave and tidal sectors such as Minesto, which received funding for its Deep Green tidal power plant.

Specific courses are available to address the skills issues for wave and tidal business development, but these are not coordinated under any specific initiatives.

From this review of business development support initiatives across various relevant sectors. and input from the steering group, it is suggested that the areas where initiatives are likely to be most effective in supporting the wave and tidal energy sectors are:

- Customer-led procurement agreements
- Direct business development advisory support
- Manufacturing advisory services
- Recruitment/skills development support
- Clustering initiatives
- Sector codes of practice (for example, for procurement and operation), and
- UK content targets/developer supply chain obligations.

A number of these are yet to be established in the wave and tidal sectors, partly due to the sectors' relative immaturity.

4. Industry views of supply chain support initiatives

As part of the interview process, a review of the support initiatives identified within the literature review was carried out under the four same headings:

- Market conditions
- Innovation support
- Financial support, and
- Business development support.

Interviews were held with representatives from 26 organisations as listed in Appendix 3. Detailed notes of these interviews have been provided separately to RenewableUK and SR.

As part of the engagement, interviewees were asked to rank the influence of initiatives (on the future development of the sectors) in each of four areas from 1st to 4th.

Interviewees were also asked to score the influence of individual initiatives on the future development of the sectors on a scale as follows:

0 – Not influential at all

1 – Slightly influential

2 – Fairly influential

3 – Highly influential

4.1. Overall Ranking

Interviewees were asked to rank the four groups of initiatives. When the results were combined a clear order of importance to the interviewees is seen in Figure 2:

1st – Market conditions support

2nd – Financial support

3rd – Innovation support

4th – Direct business development support

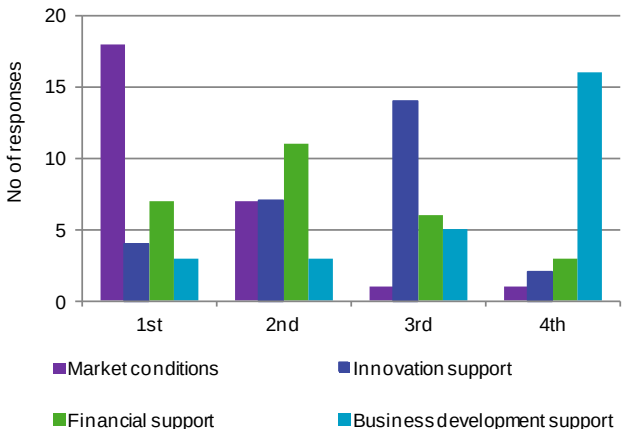

Figure 2 Ranking of the four areas for support initiatives (1st = most important).

The importance to interviewees of market conditions support and relative lack of importance of business development support also comes through when specific initiatives in each group are looked at individually. It is relevant to note, however, that each area received a first rank in at least 10% of responses. While financial support and innovation support are ranked second and third in this analysis, this order reverses when the specific initiatives in each area are looked at. This indicates that these two areas are close together in importance to interviewees.

4.2. Market conditions support

The market conditions area was ranked highest, and all four individual initiatives have scored highly as shown in Figure 3. Having strong and consistent signals of support from UK government was scored highest, followed closely by visibility and predictability of the size and timing of market growth for the UK. Having an attractive strike price for electricity from wave and tidal devices was considered important; however individual interviewees differed in their views on importance. Some stated that the current level of £305/MWh was acceptable now, others stated that it was insufficient to support the first two to three array projects, but could be acceptable after that. Other stated that the price needed to be higher(up to £350/MWh), especially for wave energy.

Figure 3 Average scores for the individual market condition support initiatives (3 = highly influential; 0 = not influential at all).

4.3. Innovation support

Innovation support was ranked third, though the individual initiatives in this area, on average, scored higher than those under financial support. Funding for demonstration projects and more general R&D funding (grants or co-funding) were scored most highly of the initiatives in this area, as can be seen in Figure 4. Interviewees specifically advised the need for demonstration of latest generations of technology and demonstration of behaviour of devices in arrays and not just singly. As such, it re-enforces the need stated above for support to help get the first few array projects into construction, as these are also in effect demonstration projects. The need for development of clear technology roadmaps was higher for interviewees speaking for the wave sector. To some extent, this initiative is

secondary, as its main effect is to provide focus and facilitate best use of public funding. There was a split between interviewees who felt that access to demonstration sites was sufficient and others who stated that more needed to be done here.

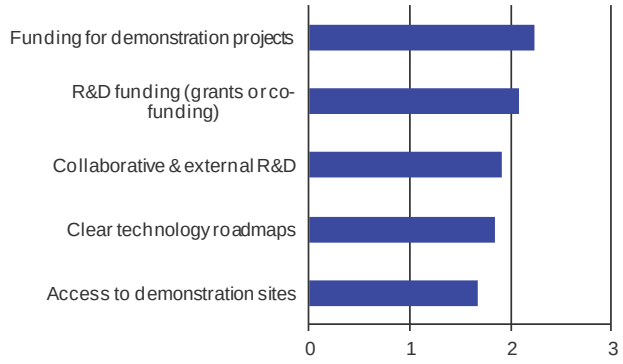

Figure 4 Scores for the individual innovation support initiatives (3 = highly influential; 0 = not influential at all).

4.4. Financial support

Financial support initiatives was ranked second, though the individual initiatives in this area, on average, scored lower than those under innovation support. Infrastructure grants scored highest of the initiatives in this area, as is shown in Figure 5. This is linked to a desire to de-risk and reduce costs of activity for supply chain companies that need to invest. Tax incentives, underwriting of loans and financing performance bonds / underwriting of contracts also scored relatively highly, and also point to the desire to de-risk activity in the sector in order to reduce costs.

Figure 5 Scores for the Individual financial support initiatives (3 = highly influential; 0 = not influential at all).

4.5. Business development support

Business development support was ranked lowest of the areas explored and the individual initiatives also scored the lowest, on average as can be seen in Figure 6. The only initiative considered on average fairly influential was for UK content targets/developer supply chain obligations. The only other influential initiative identified was direct business development support (inc. enabling commercial partnering). Interviewees frequently indicated that other initiatives in this area would only be of substantive value if the main issues facing the industry were also addressed.

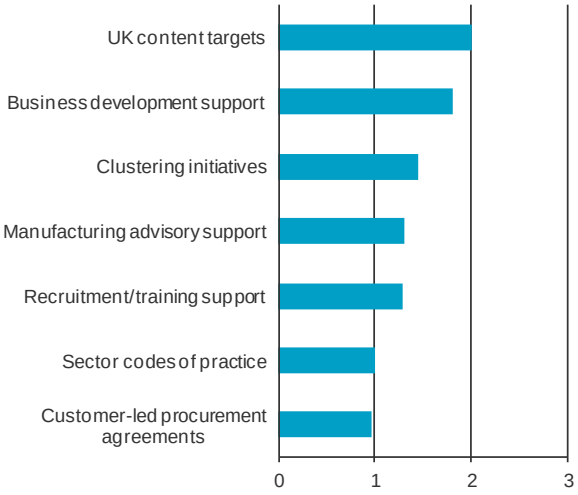

Figure 6 Scores for the individual business development support initiatives (3 = highly influential; 0 = not influential at all).

4.6. Conclusions regarding the most influential initiatives for the wave and tidal sectors

The interviews with large industrial companies not currently active in the sector indicated that the lack of certainty of future growth and timing of that growth are key barriers to their participation. Large industrials need markets with a certain size potential, and interviewees indicated that the wave and tidal sectors are still a long way from that. In these circumstances, large industrials not currently active are likely either to maintain a watching brief or participate in a limited way via supply of services, components or sub-systems that they already produce and can offer without further investment or risk.

A wide range of potentially influential initiatives was identified and discussed with a representative cross-section of the wave and tidal sectors. In order of priority, the top 8 initiatives that interviewees considered would be the most influential are:

- UK government signals of support
- UK market growth predictability
- Attractive strike price
- World market predictability
- Funding for demonstration sites
- R&D funding (grants or co-funding)
- Infrastructure grants
- UK content targets

These are considered further in Section 6.

5. UK supply chain capability and opportunity analysis

The results from the interviews concerning supply chain capability and opportunity are presented in the following sub-sections. The supply chain capability analysis is introduced then presented in tabular format in the first 12 sub-sections, followed by summaries of capability and opportunities for export by the UK supply chain. Although the focus is on the UK supply chain, it is important to put this in the context of the wider supply chain to the wave and tidal sectors, so non-UK suppliers are listed also and comments on current capacity and technology development relate to the global situation. Where possible, the sub-element definitions and colour coding follows that of a range of our reports for The Crown Estate, BIS and others, thereby facilitating transfer of knowledge and insight between sectors.

Over 85% of the interviewees advised the number of full-time equivalent (FTE) employees active on wave and tidal business in their companies, totalling 256 FTE employees. Nine of those interviewees also advised the value of their own investments made into their wave and tidal businesses, and these totalled £120m. Activity was split, on average, 70% towards tidal and 30% towards wave, where reported, though this is a small sample size and is not necessarily representative of the sectors as a whole.

The considerations covered in each table in the following sub-sections are as follows:

Proven capability: Examples of organisations with experience on projects involving devices deployed at sea and rated at over 100kW. Organisations may manufacture hardware or hold know-how and IP relevant to the sub-element.

Company names are shown in bold in the tables below to indicate where we anticipate that:

- Organisations already have at least 30% UK content in what they have supplied, or
- Have existing capability in the UK such that 30% UK content is anticipated in future projects.

Additional future capability: Examples of organisations that have the capability to supply, based on experience in similar sectors (especially offshore wind and oil and gas).

Current capacity and investment lead times: These are considered sufficient if short-term needs and future demand over the next five to ten years (considered globally):

- Can be met by incremental investment at existing or new facilities within the timescales of a given project and based on the level of commitment likely to be available in the market, or
- Are likely to be driven sufficiently by other sectors.

Supply chain overview: An overall view of the supply chain status for each sub-element, incorporating specific reference to the UK supply chain.

Technology development: The status of technology and any major technology shifts which may impact the supply chain.

Conclusion: Each sub-element of the UK supply chain was graded red, amber or green for capability, using the following definitions:

> **Green:** The capability of the UK supply chain is not currently an area of concern. Where problems have been identified, there are reasons to believe that these will be rectified by market pressures. A watching brief should be maintained, recognising that significant investment and supply chain development is still required in some cases in order to deliver sufficient capacity and capability and the right cost.
>
> **Amber:** The capability of the UK supply chain is an area of concern. Some proactive intervention is required in order to address market disconnect. This may relate to the lack, or availability, of optimal solutions, with the industry forced to use more expensive components and services.
>
> **Red:** The capability of the UK supply chain is an area of significant concern. The issue demands further analysis and strategic action. Again, this may relate to the availability only of non-optimal solutions.

Overall judgement has been used to define the grading in each case, rather than any mathematical combination of the considerations discussed above.

Recommended actions: Specific actions relating to the UK supply chain in each sub-element.

5.1. Wave/tidal farm design, development, ownership & asset management

Criterion	Wave / tidal farm design, development, ownership & asset management
Proven capability (examples only)	Alstom, **AMEC, Aquamarine Power, Black & Veatch, DP Marine Energy**, **EDF**, **DNV-GL**, **MeyGen, Pelamis Wave Power, RES, SeaRoc, Siemens (Marine Current Turbines), ScottishPower Renewables.**
Additional future capability (examples only)	**EDP Renewables**, **E.ON**, **Mott MacDonald, PMSS**, **RWE**, **SSE**, Statoil, Vattenfall.
Current capacity and investment lead time	In some cases, wave and tidal energy device developers are acting as project developers and owners due to the need to demonstrate their technologies. There is capacity for this to be taken on by entrepreneurial project developers backed by project finance, or by energy utilities (though these latter appear to have limited, or no, willingness) if the returns are sufficient.
Supply chain overview	Capacity is generally sufficient and most that has been involved in UK projects is located in the UK. Lack of existing arrays, means siting can only be based on simulation or small-scale models and there is little shared knowledge of practical issues and the implications of choices made during project design and development, which is a weakness.
Technology development	Technology will be driven by device developments and experience from first arrays.
Conclusion	A
Recommended actions	Make wave / tidal project development an attractive proposition for large utilities or project finance-backed developers.Stimulating the market for projects will help to develop the entire supply chain.

5.2. Wave energy devices and subsystems

Criterion	Wave energy devices and subsystems
Proven capability (examples only)	**Aquamarine Power**, Bosch-Rexroth, Fred. Olsen, **Pelamis Wave Power** (but now being wound-up), Wello.
Additional future capability (examples only)	Albatern, **AWS Ocean Energy**, **Seatricity**.
Current capacity and investment lead time	There remain too many players for the expected demand within the next five to ten years, but while technology is so diverse, this is anticipated to remain. This threatens to dilute efforts across too many companies and is a barrier to investment in technology development in the short term and risks impacting supply capacity increases when required.
Supply chain overview	UK capacity is OK, but so far, most bigger companies in the sector have chosen to focus on tidal energy. The overcapacity identified above could be resolved by consolidation (driven by mergers or company failures) which is likely to accelerate progress. It would be a concern, however, if this process resulted in loss of UK supply chain capability, for example if (as appears likely at the time of writing) the staff, assets or IP of Pelamis were lost to the industry.
Technology development	The current range of designs probably covers the most cost-effective long-term solutions, but are not yet ready for array-scale deployment. Development is anticipated to lead to convergence. Developments will include those in power take-off and alternative materials, including composites, with the dominant focus on survivability and cost of energy reduction.
Conclusion	
Recommended actions	Accelerate the development of the most effective technologies to the point of being ready for array-scale deployment by focussing more on likely winners. Provide smaller amounts of public funding alongside private funding for collaborative projects addressing pan-industry issues (such as Wavepod).

5.3. Tidal energy devices and subsystems

Criterion	Tidal energy devices and subsystems
Proven capability (examples only)	Alstom, **Andritz Hydro Hammerfest**, **Atlantis Resources**, **DB Wind**, **GE Power Conversion**, OpenHydro, **ScotRenewables**, **Marine Current Turbines,** Winergy.
Additional future capability (examples only)	Minesto, **Nautricity**, **Nova Innovation**, Schottel, **Sustainable Marine Energy**, **Tidal Energy Limited**, Voith.
Current capacity and investment lead time	More than sufficient for the expected demand in the next five to ten years, with sufficient devices expected to be ready for deployment in small arrays at a viable cost to enable the sector to progress. There is also sufficient UK capacity in subsystems, fabrication, machining and assembly.
Supply chain status	UK capacity and capability is generally sufficient. One concern was raised about sufficient numbers of engineers and naval architects if competing with a strong oil & gas sector.
Technology development	Tidal device architecture is mostly converged to a horizontal drivetrain axis with a two or three-bladed rotor. The dominant focus is cost of energy reduction. Key focus areas reported are: better designs for installation and retrieval and tidal-specific vessels, nacelle and mechanical-electrical power conversion chain development (especially for increased reliability), and cables and connectors. Arrays have not yet been installed and evaluated, so the trade-off between the number and rating of devices is yet to be explored fully, and the roadmap to lower LCOE is still unproven.
Conclusion	A
Recommended actions	Focus on enabling successful deployment of 2nd and 3rd arrays in UK waters (after MeyGen) by making projects sufficiently attractive to investors to drive learing and cost of energy reduction.

5.4. Foundations and mooring systems

Criterion	Foundations and mooring system
Proven capability (examples only)	**BiFab**, **Bluewater**, **Fugro Seacore**, **Global Energy Group**, **Sustainable Marine Energy**.
Additional future capability (examples only)	Aker Verdal, Bauer Renewables, Bladt, Crist/Bilfinger Berger, **Harland & Wolff**, Jade Werke, Navantia, **OGN Group**, **Steel Engineering**, Smulders Group, STX Europe, WeserWind.
Current capacity and investment lead time	Due to the low level of demand anticipated in the next five to ten years, and the synergies with the offshore wind and oil gas sectors, there is sufficient capacity at the moment. Some suppliers have faced financial difficulties or have withdrawn from the market which has reduced capacity, but the remainder is sufficient unless there is a big upturn in offshore wind demand.
Supply chain overview	UK capacity and capability is sufficient, but cost effective, tailored solutions for tidal and wave systems are not yet available.
Technology development	Fixed foundation technology currently broadly follows wind practice, but developments are expected in sector-specific “float-out-and sink” and moored technologies and in improving and potentially standardising the interface between device and foundation / mooring system.
Conclusion	A
Recommended actions	Prioritise technology development and demonstration of sector-optimised solutions, particularly for tidal devices.

5.5. Subsea array and export cables

Criterion	Subsea array and export cables
Proven capability (examples only)	Draka (Prysmian Group), **JDR Cable Systems**.
Additional future capability (examples only)	ABB, Hellenic Cables, Nexans, NKT, NSW General Cable, **Oceaneering**, Parker Scanrope.
Current capacity and investment lead time	Capacity exists across Europe to serve the wave, tidal, offshore wind and parallel markets today, and logistics are not a significant issue for cable supply in general. Lead times for new investment are the order of three years from investment decision for a new location or two years for expanding an existing location. It is unlikely that the wave and tidal sectors will drive the demand for new supply due to the synergy with requirements for offshore wind. Connector capacity could be more of an issue if demand increases quickly, as these are not used in offshore wind, except in the nascent floating sub-sector.
Supply chain overview	UK has one strong player, JDR Cable Systems, that is seeking to increase scope of supply and has a strong technology development pipeline. Other UK players in offshore wind and oil and gas could enter the renewables market. In offshore wind, there is a consolidation of cable supply and install packages by project developers. Typically, supply is led by installers (see Section 5.9). This is likely to follow in the wave and tidal sectors.
Technology development	There are no major developments in cables expected that won't be driven first by offshore wind (for example dynamic cables). There is a tidal-sector specific need for higher voltage (e.g. 33kV) wet-mate connectors and cable protection arrangements for high-flow conditions. Technology development should also focus on standardised architectures to help reduce cost and uncertainty.
Conclusion	G
Recommended actions	Support the development of wet-mate and and cable protection arrangements for high-flow conditions.

5.6. Substation electrical systems

Criterion	Substation electrical systems
Proven capability (examples only)	**GE Power Conversion**.
Additional future capability (examples only)	**ABB**, **Alstom Grid**, CG Power, Schneider Electric, **Siemens Energy Transmission**.
Current capacity and investment lead time	Substation requirements have been limited due to most installations being single units only. Offshore wind and oil and gas capability is likely to be used directly, where needed, but while projects remain small and close to shore, equipment located offshore may be minimal. Capacity not expected to be an issue, but will be a mix of European and some UK content..
Supply chain overview	The UK has a strong high voltage power sector. There is a global supply base for large electrical components, but most offshore substations for UK wind farms have been built in the UK, partly because of experience of building offshore oil and gas platforms. Incremental investments are ongoing, with a focus in offshore wind on higher voltages, a trend unlikely to be followed in the wave and tidal sectors due to lower device ratings, thereby separating the demand, somewhat. UK supply chain capacity and capability is sufficient for the substation electrical requirements of wave and tidal.
Technology development	Alternative current (AC) substation technology is well established. Development is required on sub-sea hubs, with effective installation/ retrieval methods for cables/ connectors and other components.
Conclusion	G
Recommended actions	Prioritise development and demonstration support for systems suitable for (first) tidal and (then) wave projects.

5.7. Installation ports

Criterion	Installation ports
Proven capability (examples only)	**Belfast**, **Falmouth**, **Orkney Ports**, **Pembroke**, **Scrabster**.
Additional future capability (examples only)	Dublin, **Liverpool**, **Mostyn**, **Southampton**, Cherbourg. Logistics costs mean that ports local to project sites will be used. New wave and tidal project sites will therefore dictate future port requirements.
Current capacity and investment lead time	Investment in coastal facilities is underway in some areas. Lead times if new quayside development is required is five to ten years.
Supply chain overview	The UK supply chain has sufficient capacity and capability for the expected growth, however locations are not optimised.
Technology development	None
Conclusion	A
Recommended actions	Provide early definition of next array sites to enable port planning. Provide financial support to activity that may need to be commenced ahead of project-specific commitments.

5.8. Foundation and device installation

Criterion	Foundation and device installation
Proven capability (examples only)	Bauer Renewables, **DOF Subsea**, **Green Marine**, **James Fisher Marine Services**, **McLaughlin & Harvey**, NorWind, SAL Heavy Lift, Scaldis.
Additional future capability (examples only)	Geosea, Jumbo Offshore, **MoJo Maritime**, Van Oord.
Current capacity and investment lead time	Supply chain has the capacity to meet demand, but not necessarily with vessels optimum for the sectors.
Supply chain overview	There are a significant number of capable installation suppliers in the market, but competition for vessels from oil and gas and offshore wind might limit capacity for wave and tidal sector. Capability is not fully developed, and currently there appears insufficient incentive for installers to invest in bringing forward the required innovations and optimisations to significantly reduce cost.
Technology development	Optimising approaches for installation and retrieval on sites with high wave and high tidal flow conditions (thus with short installation windows) is a key focus area. Development of dedicated vessels and installation approaches for lower cost and lower risk installation and retrieval is required (see 5.11).
Conclusion	
Recommended actions	Support development of new installation methods developed holistically alongside vessels, foundation and device designs that are lower cost to install. Drive standardised interfaces in due course.

5.9. Subsea cable installation

Criterion	Subsea cable installation
Proven capability (examples only)	**DeepOcean, James Fisher Marine Services**, **Mojo Maritime**, **SeaRoc**.
Additional future capability (examples only)	**Ecosse Subsea**, Jan de Nul, Nexans, **Offshore Marine Management**, Prysmian, **Reef Subsea**, Siem Offshore, Tideway, Van Oord, VBMS.
Current capacity and investment lead time	UK capability and capacity is sufficient unless vessels are fully utilised by offshore wind and oil and gas sectors.
Supply chain overview	James Fisher has invested in capability for wave and tidal projects. Investments to support other sectors should increase capability available for wave and tidal, as long as sector-specific requirements are built in to new designs.
Technology development	Optimising approaches for cable handling, installation and burial in sites with high wave conditions and high tidal flow conditions are required to in order to reduce installation time and risk and lifetime cost. Cable stability on bare rock with high currents needs to be addressed with more cost effective solutions than are currently available.
Conclusion	A
Recommended actions	Document the requirements for specialist vessels/ equipment for cable installation at tidal sites, to ensure capability incorporated into new-build vessels for other sectors. Support development of cable solutions for areas of high current.

5.10. Small vessels and equipment

Criterion	Small vessels and equipment
Proven capability (examples only)	AF Theriault, **Alicat/South Boats**, **Alnmaritec**, Austral, **CTruk**, Damen, **Delta Marine**, **Green Marine, James Fisher Marine Services**, **Leask Marine, Sula Diving**.
Additional future capability (examples only)	Multiple companies operating locally and nationally.
Current capacity and investment lead time	UK capacity and capability is sufficient (there is even an oversupply in offshore wind). Maintenance and service of wave and tidal devices is much more likely to require retrieval and return to port than on-site repair, reducing the demand for smaller vessels in the near-term, unless solutions are developed that can be implemented using such vessels.
Supply chain overview	There is strong competition in the small and personnel transfer vessel operators market, with UK suppliers playing an active role.
Technology development	Development of moored “towable” wave and tidal technologies may increase demand for smaller (or mid-sized) vessels over larger, more capable ones.
Conclusion	G
Recommended actions	Document the requirements for specialist vessels / equipment for cable installation at tidal sites.

5.11. Larger vessels

Criterion	Larger vessels
Proven capability (examples only)	**Fugro Seacore, James Fisher Marine Services**.
Additional future capability (examples only)	Geosea, Jumbo Offshore, Scaldis, Seaway Heavy Lifting (Subsea7), Swire Blue Ocean, Van Oord.
Current capacity and investment lead time	Overall capacity is high, in part driven by demand for offshore wind vessels, but these are far from being optimised in capability. There is some UK capacity but it will be insufficient to meet demand in future.
Supply chain overview	There are a significant number of vessels in the market, but these are not adapted to the needs of the sector, so are expensive, slower and higher risk than sector-specific designs.
Technology development	Optimising vessels for installation and retrieval in sites with high wave conditions and high tidal flow conditions. Ultimately, dedicated vessels are required for lower cost installation, retrieval redeployment of devices.
Conclusion	A
Recommended actions	Support development of new installation vessels for foundations and devices.

5.12. Consultancy and R&D services

Criterion	Consultancy, R&D and other services
Proven capability (examples only)	**Aquamarine Power**, **Aquatera**, **Black & Veatch**, **BVG Associates**, **DNV-GL**, **EMEC**, **Fugro Seacore**, Hyder Consulting**, IT Power**, **Mojo Maritime**, **Mott Macdonald**, **ORE Catapult**, **Pelamis Wave Power**, **Qinetiq**, **RES**, Royal Haskoning, **SeaRoc**, **UK universities (Bristol**, **Edinburgh**, **Plymouth**, **Queen's University Belfast**), **Xodus Group**.
Additional future capability (examples only)	Multiple companies in marine, oil and gas and offshore wind consulting and R&D.
Current capacity and investment lead time	Sufficient due to relatively slow progress in the sectors.
Supply chain overview	UK capability and capacity is good compared with other countries. Even so, experience is limited because of limited deployment of wave and tidal energy devices so far, and tools are largely yet to be validated. Site characterisation and environmental data collection remain high cost and risk for developers.
Technology development	New software tools and test facilities will be required as the sectors mature.
Conclusion	A
Recommended actions	Support development of test facilities according to industry needs.

5.13. Summary of UK supply chain capability

Interviewees advised concern about two thirds of the sub-elements of the supply chain, as summarised in Table 1 below. In general, capacity was advised to be sufficient due to the relatively slow anticipated expansion of the wave and tidal sectors and the synergies with other sectors, which have much higher demand. Concern related more to the availability of technical solutions that facilitated a sustainable cost of energy for the sectors, especially where sector-specific solutions are required. Wave energy devices and subsystems was the only area with a high level of concern, due to the gap between solutions available and what is needed for early commercial arrays.

Table 1 Supply chain status summary.

	Supply chain sub-element	Summary actions	Supply chain element
A	Wave / tidal farm design, development, ownership & asset management	Support to make more attractive to project developers and investors.	**Development and project management**
R	Wave energy devices & subsystems	Focus down onto the leading technologies and accelerate development of those.	**Device supply**
A	Tidal energy devices & subsystems	Focus on enabling deployment of 2nd and 3rd arrays.	
A	Foundations and mooring systems	Supply chain support and motivation to develop and demonstrate cost effective solutions, particularly for tidal.	**Balance of plant supply**
G	Subsea array and export cables	Support the development of wet-mate and cable protection arrangements for high-flow conditions.	
G	Substation electrical systems	Prioritise development and demonstration support for systems suitable for (first) tidal and (then) wave projects.	
A	Installation ports	Early definition of next array sites to help ports prepare and undertake long-lead developments.	**Installation and commissioning**
A	Foundation and device installation	Supply chain support to develop and demonstrate cost effective installation solutions.	
A	Subsea cable installation	Supply chain support to develop and demonstrate cost effective installation solutions.	
G	Small vessels and equipment	Document the requirements for specialist vessels / equipment for cable installation at tidal sites.	**Vessels**
A	Larger vessels	Support for development of new vessels for efficient cable, foundation and device installation and retrieval.	
A	Consultancy and R&D services	Support development of test facilities according to industry needs.	**Other**

5.14. UK supply chain opportunity

Most interviewees advised that the UK supply chain was well placed to support the full scope of supply for wave and tidal energy. Even in areas where they are currently using imports such as gearboxes, generators and hydraulic components, some capability exists in the UK to supply. When considering export, however, most advised that a smaller scope of supply is likely. This is due to the existence of competitive overseas supply chains, even if not experienced in the sector, and the lack of export credit and other de-risking and cost-reducing instruments for the current scale of activities. Industry players recognise the size of components and the benefit of final assembly close to the project site. The large and heavy nature of many components may lead to fabrication and final assembly activities being located at an assembly site close to the installation site in some (but not all) cases. The offshore wind industry being an example where large components and assemblies are exported considerable distances.

Key opportunities identified for export were advised by interviewees to be:

- Device and component/sub-system supply and related IP
- System engineering, including design, manufacture and integration
- Specialist skills & expertise, including in project development, installation and operation management

A wide range of target export territories was identified by interviewees. Canada and France were identified most often by interviewees as key targets, followed by Japan, Korea and the USA. Clearly, export to France offers different opportunities to the long-haul markets, but France also has a history of government-policy actively supporting local content, even at the cost of competition.

6. Conclusions

1. Following a review of programmes across multiple sectors, relevant supply chain support initiatives for the wave and tidal sectors were identified. These were discussed with industry stakeholders in 26 structured interviews, in one of the most thorough engagements yet with the sectors. The areas in which wave and tidal sector players declared initiatives are needed, in priority order, are:
    - UK Government signals of support
    - UK market growth predictability
    - Attractive strike price
    - World market predictability
    - Funding for demonstration sites
    - R&D funding (grants or co-funding)
    - Infrastructure grants, and
    - UK content targets.
2. The first four of these areas come under the heading of market conditions support. It is clear that a number of these initiatives together are required in order to establish a sufficiently large market in the UK to facilitate proactive supply chain investment. Actions in the other areas also need to be taken to maximise the benefit of the growth of this market for the UK economy.
3. The interviews with large industrial companies not currently active in the sector also indicated that the lack of certainty of future growth and timing of that growth are the key barriers to their participation. Large industrials need sight of markets with a size potential well into the hundreds of MW per year, as exemplified by the declaration of intent by Siemens to exit the sector by selling Marine Current Turbines.
4. The sectors have supply chains that benefit from synergies with a number of parallel sectors as well as each other. As a result, no parts of the supply chain are expected to slow the growth of the sectors, given confidence to invest. Sufficient supply will be available after investment in response to firm demand – there is time to grow - and these investments are expected also to lead to reduction in cost of energy.
5. A wide range of target export territories for the supply chain companies was identified by interviewees. Canada and France are key targets, followed by Japan, Korea and the USA. Clearly, export to France offers different opportunities to the long-haul markets, but France also has a history of government-policy actively supporting local content, even at the cost of competition.
6. Significant supply chain opportunities for export were identified as:
    - Device and component / sub-system supply and related IP
    - System engineering, including design, manufacture and integration, and
    - Specialist skills & expertise, including in project development, installation and operations management.

    Market-leading, successful UK wave and tidal sectors could target winning exports of up to 25% of the value of non-UK projects as the sectors mature, based on the experience of German and Danish suppliers exporting to the onshore and offshore wind sectors.
7. Both the wave and tidal sectors now have a small pool of players with single devices with months' or years' of operating experience. These players have a realistic understanding of their baseline CAPEX. OPEX is less certain due to uncertainties about future reliability and future costs of fixing faults once retrieval methods have been improved. Energy production, cost of finance and device lifetimes also have uncertainty, meaning that even the market leaders have significant uncertainty in forecasting levelised cost of energy (LCOE) for existing and future projects.
8. The CfD strike price for early projects appears to have enabled the financial close of the first tidal array project, developed by Meygen. It should be noted, however, that nearly 80% of the finance required has come from public or quasi-public sources. These lenders were prepared to take a potentially higher risk than conventional lenders, at a normal commercial interest rate. The Skerries project, however, failed to proceed. Without the sort of well-recognised and documented track-record and future route to LCOE reduction of onshore and offshore wind, the sectors will continue to struggle to be able to strike a credible deal with government about a future that delivers benefits to all. Without visionary action, it is suggested that neither sector will prove attractive for public or private investment, in line with the recent news from a number of high-profile organisations.
9. For the tidal sector, we suggest that this visionary action should have the aim of achieving a range of LCOE comparable to that of offshore wind by the point at which 2GW is installed. Offshore wind is on a trajectory to reduce its own costs to below an estimated £90/MWh by 2030. If the current volume of tidal energy devices installed to date is taken as 5MW, then 8.5 doublings in volume will have occurred by the time 2GW is reached. If the current LCOE for tidal energy is taken as £305/MWh, we calculate that an LCOE learning rate of 13% for every doubling of installed volume from now until the first 2GW is operational is required. While this learning rate has

been seen at times in the wind industry, it is marginally beyond the long-term average estimated at 10-12% over the first few decades of deployment. Achieving this learning rate will be hard and will require a more proactive approach than the wind industry's project-by-project approach. It also requires agreement about the right pace of market development to maximise the efficiency of learning. Volume growth that is too fast reduces the opportunity for learning between projects and drives too expensive a support mechanism. Volume growth that is too slow is worse, and risks LCOE dropping too slowly and the gap with offshore wind remaining, undermining the logic for a future for the sector.

10. For the wave sector, the focus also needs to be on LCOE. The key difference from the tidal sector is that technology choice is still uncertain and the global market has the potential to be much larger. The priorities therefore are:

    - accelerating identification and selection of the optimum technologies, and
    - parallel development for performance and reliability of critical components, subsystems and services that are likely to be needed whatever the technology choices.

    These priorities appear to align with the ambition of the newly formed Wave Energy Scotland organisation.

7. Recommendations

It is the establishment of a new and credible deal with Government that is at the heart of the recommendations below. We consider this critical to the future of the sector in an environment where there is a pan-European trend away from technology-specific support.

1. The sectors need to establish and commit to credible pathways to a market size, UK turnover, socioeconomic benefit and most importantly, LCOE trajectory. This needs to be at a rate against MW installed and at an investment cost that it makes sense for governments to support. The pathways need technical, cost and market size milestones that can be monitored to give confidence in progress.

2. It is clear that the fundamental prerequisite for growth in the supply chain is establishment of a market and visibility of market growth. This growth needs to be to a sufficient size to be attractive to suppliers. There are initiatives that can be taken to facilitate this, that hold the sectors accountable. The priority initiatives to support market growth are listed in Table 2 below.

3. In parallel, there are other initiatives that can ensure that the supply chain adds as much value to the UK economy and creates as many UK jobs as possible. By creating the first significant market for wave and tidal energy and meeting the demand primarily using the UK supply chain, we will be able to build up the relevant skills and experience and put the UK in the best position to benefit from exporting to the global market, which we are confident, will follow. The priority initiatives to support market growth are listed in Table 3 below.

4. Additional recommendations are listed in Table 4.

Table 2 Key recommendations – market growth.

Recommendation	Actions	Owner	Timescale or relationship to installed volume	Comment
1. Accelerate focused technology development and deployment	**For tidal**: R&D funding for cost and risk reduction projects including installation and construction. The focus should be on technology development and demonstration of non-wind derived foundation & mooring systems and installation solutions for foundations, devices and cables, always with an eye to solutions that can give sufficient LCOE savings. Project support funding to enable the next 2-3 arrays to be financially viable and to accelerate their construction.	DECC / GIB / SE / ORE Catapult co-funding	Array projects: Now to 50MW installed tidal energy capacity; R&D, ongoing.	Existing funding provided by: WATERS - £14m SE £2.4m Tidal Array Cabling Solution project Marine Energy Commercialisation Fund (MRCF) - £18m Renewable Energy Investment Fund: £103 million
	For wave: R&D funding for projects, accelerating identification and selection of the optimum technologies, and development of critical components, subsystems and services that are likely to be needed whatever the technology choices.	DECC / /ORE Catapult / WES co-funding	Until 10MW installed wave energy capacity. Funding route thereafter may follow the tidal model.	Additional funding / loans will need to be provided for the first few arrays covering a high proportion of costs Additional funding may be required to deliver fast response, and pro-active (not technology-neutral) interventions.
2. Provide infrastructure funding to enable efficient build-out	Funding availability for new grid connections and generic project infrastructure such as port upgrades. This should be in parallel with development of projects noted above and with support to the development of the 'needs case' for the transmission operator.	LEPs / SE / HIE	Now to 2020	Port infrastructure development lead times are 4-5 years.

Table 3 Key recommendations – maximising UK content.

Recommendation	Actions	Owner	Timescale or relationship to installed volume	Comment
1. Develop a route to a sustainable supply chain that offers sufficient local content and export benefits to warrant government support of its development	Development and publication of statements regarding market size expectations and CfD strike price levels or negotiation mechanisms beyond 2020. Development and publication of UK content monitoring / supply chain plan requirements, with a plan for implementation of the associated legislative instruments. Development of ambitious 'industry aspiration' targets for UK content in domestic & export projects, in the region of 70% and 25% respectively.	DECC	Q4 2015	Current CfD/RO funding for up to 100MW only applies at current rate until 2020. CfD is currently fixed and is generally not negotiated on a case-by-case basis. Supply Chain Plans are not currently required for wave and tidal projects under 300MW. A UK content methodology has just been approved for offshore wind.
2. Establish industry and government needs in order to jointly deliver a robust future for the wave and tidal sectors	Development and publication of a cross-department government strategy. This should be roughly in line with the industrial strategies published for other sectors, but shorter and more focused, recognising the smaller scale of these sectors compared with the other major industrial strategies. It should recognise the difference between the wave and tidal sectors and document government intent towards the industrialisation of each.	DECC / RUK / Industry (MSG)	Q4 2015	Industrial strategies have, to date, been focused on bigger sectors. Offshore wind is by far the smallest sector currently with a government industrial strategy – it is not anticipated that a similar, full process will be undertaken.
	Publication of agreements between Westminster and Holyrood about how to collaborate to develop the sectors.	DECC / Scottish Government	Q4 2015	

Table 4 Other recommendations.

Recommendation	Actions	Owner	Timescale or relationship to installed volume	Comment
1. Establish baselines and justified trajectories for LCOE for some representative site conditions, using methodologies common to the more established wind sectors and based on agreed, plausible installation forecasts, taking account of future costs of competing low carbon technologies	**For tidal**: publication of an industry-led report with transparency on current cost of energy and thoroughly documented pathways to cost of energy reaching parity with competing technologies. This needs also to document pre-requisites for delivery of this pathway and milestones to show progress. Tracking of progress should be in a formalised monitoring framework, primarily against GW installed rather than against time. **For wave**: as for tidal, but with more uncertainty allowed due to the less mature technology status.	The Crown Estate	Q3 2015	Previous roadmaps (ETI marine energy roadmap; BIS / INNOVATE UK / UK Marine Industries Association roadmap) are time-based. If they are over-optimistic in terms of the rate of installation they will also be over-optimistic in their projections of LCOE reduction. The Crown Estate and KIC InnoEnergy processes could be simplified for use here, taking the valuable learning from these activities.
2. Improve world market visibility	Funding for ORE Catapult to produce an authoritative annual global market update for the sectors.	BIS / ORE Catapult	Q2 2015 and then annually	It is recognised that UK stakeholders have little impact on the market outside of the UK. Consistent assumptions and realism still need to be applied to global as well as UK forecasts.
3. Increase bank and investor understanding of the technology, supply chain and markets	Funding for further development of internationally recognised standards for project and device design.	INNOVATE UK / ORE Catapult / EMEC	Q2 2016	Development of guidelines can be faster and a pre-cursor to standards
	Increased cross-sector engagement forums with financiers and their advisors,	BIS / RUK / SR / MEPB	Q4 2015	Not currently done but has been useful in other sectors. Objective is not just to seek to increase their confidence regarding a given project, but also to understand their views in order to influence technology and project development, long-term.

Recommendation	Actions	Owner	Timescale or relationship to installed volume	Comment
4. Support exports	Increased use of export credit support and other de-risking and cost-reducing instruments.	BIS / RUK / SE / HIE / SR	Ongoing	Proactive connection of companies (especially SMEs) to these services.
	Further use of UKTI and FCO posts in relevant markets, and the development of export missions to coincide with market developments.	BIS	Ongoing	
5. Support skills training	Investment in indentifying skill shortages and skills training. Identification of cross-training opportunities (eg from the defence sector).	RUK / SR	Ongoing	
6. Establish clusters	Support to clustering (where it is starting to happen naturally).	LEPs / SE / HIE	Ongoing	Support needs co-ordination nationally to avoid unwanted competition.

Appendix 1 List of programmes considered during the literature review

Initiative / Item	Industry supported	Primary Organisations
Advanced Manufacturing Supply Chain Initiative	Range of sectors	BIS/Innovate UK/ Birmingham City Council
Aerospace Finance Forum	Aerospace	Aerospace Growth Partnership
Automotive Joint Industry Forum	Automotive	Automotive Council/British Bankers Association (BBA)
Automotive Technology Roadmap	Automotive	Automotive Council
British Water Innovation Exchange	Water	British Water
Catalyst Funds	Range of sectors	Innovate UK (Formerly TSB)
Catapult Programme (High Value Manufacturing Catapult , ORE Catapult)	Range of sectors	Innovate UK (formerly TSB)
Coastal Communities Fund	Marine infrastructure for enabling a range of sectors	The Crown Estate
Energy Island Programme	Low carbon generation technologies	Anglesey Council
Energy Technologies Institute	Low carbon energy technologies	Government-industry partnership
Environmental Transformation Fund	Low carbon technologies	DECC
European Regional Development Fund	Range of sectors	EU/Department for Communities and Local Government (DCLG)
GROW: Offshore Wind	Offshore wind	AMRC, Grant Thornton, MAS, RenewableUK
High Value Opportunities Initiative	Range of sectors	UKTI
Low Carbon Vehicle Innovation Platform	Automotive	Innovate UK
Low Carbon Vehicle Partnership	Automotive	Department for Transport/BIS/Industry
Manufacturing Advisory Service / Scottish Manufacturing Advisory Service	Range of sectors	BIS/Scottish Enterprise
National Aerospace Technology Exploitation Programme	Aerospace	Aerospace Growth Partnership
North West Automotive Alliance Business Excellence Programme	Automobile	EA Technology, Jaguar Land Rover, MI Tech, Norton-Villiers
Offshore Wind Cost Reduction Pathways Study	Offshore Wind	The Crown Estate

Initiative / Item	Industry supported	Primary Organisations
Offshore Wind Expert Support Programme	Offshore Wind	Scottish Enterprise
Offshore Wind Industrial Strategy	Offshore wind	BIS
Offshore Wind Project Timelines	Offshore Wind	RenewableUK
Open Innovation Campuses	Range of sectors	Range of initiative owners
Project Pathways	Oil and Gas	DECC
Regional Growth Fund	Range of sectors	BIS
Tees Valley Catalyst Fund	Range of sectors	LEP Tees Valley Unlimited
The Aerospace Finance Forum	Aerospace	AGP
UK Export Finance Support Programmes	Range of sectors	UK Export Finance

Appendix 2 Interview Aide Memoire

Company Name

Notes: Statements in *italics* are BVG Associates comments.

Time and date of call: hh:mm dd/mm/2014 (GMT)

Name	Company	Position
Name	**Company**	Position
Name	**Company**	Position
Name	**BVG Associates**	Position
Name	**BVG Associates**	Position

Background and information sharing
We are developing a report on behalf of RenewableUK and Scottish Renewables to allow the organisation to drive a positive agenda with government and industry to grow a valuable, sustainable and confident supply chain for the tidal and wave sectors. There are two main areas for discussion within this interview: 1. Decision factors for investment in the UK tidal and wave sectors' supply chains 2. Current status and potential for the UK supply chains for the tidal and wave sectors. This is building on the Marine Energy Program Boards report from earlier this year. We are engaging with a range of people engaged (or with the potential to become engaged) in the tidal and wave sectors in order to determine the status of the UK supply chain and to determine if, and what, intervention could be undertaken in order to further support the industry. Information gathered during this interview will only be shared with RenewableUK and Scottish Renewables and will not be published. Only anonymised and collated results will be published in the final report.

The project is looking at the following "Sub-elements" – which ones are your company engaged with?	
Wave/tidal farm design	
Wave/tidal farm ownership	
Wave/tidal operations and asset management	
Survey vessels	
Wave energy devices and subsystems	
Tidal energy devices and subsystems	
Foundation and mooring systems	
Subsea array and export cable	
Substation electrical systems	
Installation ports	
Foundation and device installation	

The project is looking at the following "Sub-elements" – which ones are your company engaged with?	
Subsea cable installation	
Smaller vessels and equipment (personnel & small component transfer)	
Larger vessels (with lifting capability)	
Consultancy, R&D and other services	

Market drivers for investment in the UK tidal and wave sectors

In the following section we list some conditions or initiatives that may support companies to increase their investment or activity in the UK tidal and wave sector supply chains. Please indicate how important these factors are in the decision making process within your company.

Scoring: 0 – Not influential at all, 1 – Slightly influential, 2- Fairly influential, 3- Highly influential

1.1 Market conditions

Condition/initiative	Score 0-3	Comment, more details on requirements
Strong and consistent signals of support from UK government		Do you feel you are getting this? Is it getting better or worse?
An attractive strike price for electricity from wave and tidal devices		What is an attractive strike price?
Visibility/predictability of size and timing of market growth: - **For UK** - **For the rest of the World**		Is there good visibility of where the market is going by when and do people trust predictions?
Any other market conditions/initiatives that would impact decision making regarding investment in the tidal and wave sectors?		

1.2 Innovation support initiatives for supply chain companies

Condition/initiative	Score 0-3	Comment, more details on requirements
R&D funding (grants or co-funding)		
Funding for demonstration projects		
Access to demonstration sites		
Increasing collaborative R&D/ improving access to external R&D expertise		
Development of clear technology roadmaps		

Condition/initiative	Score 0-3	Comment, more details on requirements
Any other innovation conditions/initiatives that would impact decision making regarding investment in the tidal and wave sector? **Have any initiatives that have been delivered with an aim of supporting Innovation in these sectors been effective and if so which ones?**		

1.3 Financial support initiatives for supply chain companies

Condition/initiative	Score 0-3	Comment, more details on requirements
Infrastructure grants		
Tax incentives for investment		
Underwriting of loans		
Direct investment in company		
Increasing understanding of technology and market of banks and investors		
Access to working capital		
Financing performance bonds / underwriting of contracts		
Opportunities to invest in collaborative funding of projects to demonstrate your sub-element		
Any other financial conditions/initiatives that would impact decision making regarding investment in the tidal and wave sector? **Have any initiatives that have been delivered with an aim of supporting financing in these sectors been effective and if so which ones?**		

1.4 Business development support for supply chain companies

Activity/initiative	Score 0-3	Comment, more details on requirements
Availability of manufacturing advisory support		
Recruitment/ training support		
Clustering initiatives (eg SW Marine Energy Park)		
Direct business development advisory support (inc enabling commercial partnering)		
Sector codes of practice (for procurement and operation)		
UK content targets/ developer supply chain obligations		
Customer-led procurement agreements		
Any other business development initiatives that would impact decision making regarding investment in the tidal and wave sector? **Have any initiatives that have been delivered with an aim of supporting direct business development in these sectors been effective and if so which ones?**		

1.5 Overall which of these would have the biggest impact on the decision making process when assessing whether to increase your level of investment in the tidal and wave sectors in the UK?

	Rank (1 (highest - 4 lowest)		Rank (1-4)
Market conditions (e.g. an attractive strike price)		**Business development support initiatives** (e.g. manufacturing advisory support)	
Innovation support initiatives (e.g. R&D funding, demonstration site accessibility)		**Financing support initiatives** (e.g. tax breaks for investment, capital grants)	

1.6 UK content (if relevant)
Which/if any of the above initiatives would increase the likelihood of using a UK supply chain for your activities in these sectors? **What are the main barriers affecting investment in the UK wave and tidal supply chain?**

2.1 Current/ Potential supply chain capacity of company

To date what extent have you delivered products or services to the tidal and wave sectors?

How many employees (Full Time Equivalent) are currently working on W&T projects, and how much has your company invested in growing your capability in this sector (including R & D reinvestment, business development, employee time)? (split by %W and %T if possible)

To what extent are you planning to supply products or services to this sector?

Which other developers / supply chain companies have you collaborated with in this sector to date? (approximate number of companies and names of main companies)

2.2 Competitors/ new entrants to the sector

Who do you consider to be your key competitors in this sector currently and in the future?

From which sectors do you think there is the greatest opportunity for diversification into supplying this sector?

2.3 UK opportunities

In which subelements do you believe the UK has the greatest opportunity to build a supply chain for tidal and wave projects in the UK and why?

In which sub-elements do you believe the UK has the greatest opportunity to build a supply chain for the export market and why?

In which countries do you believe the UK has the greatest opportunity build a supply chain for the export market?

2.4 Sector supply chain capacity

Considering the European/Global situation, in which sub-element areas is capacity insufficient to meet the demands of the projected growth of the tidal and wave sectors?

How long do you think would be required to ramp-up to meet the demands of the growing the tidal and wave industry?

2.5 Technology development

Where do you anticipate the greatest changes in technology will be and do you believe this will impact the UK or global supply chain?

2.6 Any other comments?

Appendix 3 List of organisations participating in interviews

Organisation	Areas of interest
Alstom Power	Tidal energy device; substation electrical systems
Andritz Hydro Hammerfest	Tidal energy device
Aquamarine Power	Wave energy device
Atlantis Resources/Meygen	Tidal energy device; project development
Babcock	Not currently active, but watching the sector
BAE Systems	Not currently active, but watching the sector
Bluewater	Foundation
Bryan J Rendall	Substation electrical systems
Burntisland Fabrications (BiFab)	Foundations and mooring systems
Found Ocean	Foundation and device installation; subsea cable installation
GE Power Conversion	Substation electrical systems
Global Energy Group	Foundation and device installation; subsea cable installation
James Fisher Marine Services	Foundation and device installation; subsea cable installation
JDR Cable Systems	Subsea array and export cables
Leask Marine	Vessels
Mojo Maritime /Aurora ventures	Vessels
Pelamis Wave Power	Wave energy device
Pembroke Port	Port services to offshore renewables
Prysmian Cables	Subsea array and export cables
RES	Project development; consulting
Scottish Power Renewables	Project development
Scrabster Port	Port services to offshore renewables
SeaRoc	Foundation and device installation
Siemens (including Marine Current Turbines)	Project development; tidal energy device
Sustainable Marine Energy	Foundations and mooring systems

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