

TIDAL AND MARINE ENERGY IN THE UK– IDENTIFYING THE FUTURE CHALLENGES FOR SUPPLY CHAIN DEVELOPMENT

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ABSTRACT

The purpose of this paper is to investigate the current technical and operational supply chain issues surrounding the development of tidal and marine energy production in the UK. The paper outlines the market and growth potential of tidal energy production in the UK before identifying the key supply chain themes surrounding tidal energy production including an analysis of the portability and transferability of current supply chain thinking and development from other renewable energy systems such as wind turbine technology towards the development of tidal energy supply chain systems. The paper closes by identifying the major challenges that the UK supply chain must overcome in order to develop a comprehensive and robust supply chain system.

Keywords: Supply Chain, Renewable Energy, Tidal Energy.

1 INTRODUCTION

Successive UK governments have focussed on renewable energy technologies and systems in an attempt to resolve our impending energy production crisis as well as meeting various environmental carbon reduction targets. It can be argued that wind turbine technologies are well established with its associated UK supply chain now beginning to develop and grow for both the offshore and domestic power generation markets (<http://wind-energy-the-facts.org>). The next developmental stage is now focussing upon wave energy systems in the form of tidal and other marine energy systems. Court (2008) goes on to state that the estimate for the world production of wave energy varies significantly, from between 8,000 to 80,000 TWh/y, although that which is convertible to electricity has been estimated to be considerably less and quoted to be around 2,000 to 4,000 TWh/year. For the UK, Court’s report states that a practical generating capacity of 700TWh/y is likely which is almost double today’s electricity consumption.

However, some of the energy produced will prove to be impractical to harness and estimates of economical recovery of wave energy suggest that wave energy devices could contribute to around 50TWh/y of the UK’s total energy demand. The issue of using wave power over wind power systems is that wave power is much more predictable than wind power and increases during the winter, when the electricity demand is at its highest. In 2009, the Parliamentary Office for Science and technology stated that the UK has approximately 35% of Europe’s total wave resource, the waves with the greatest energy are situated off the northwest coast of Scotland, where the power (measured in energy

per second) averages almost 50kW per metre and can reach 90kW per metre thus providing huge potential for serious energy production capability and capacity. Also, the seas off the southwest coast of England and Wales are also high in potential and so it is possible from a supply chain perspective to start to identify the key location points from which a local supply chain system will need to develop and emerge.

To further complicate the supply chain logistics issue, wave energy is highest in open seas, and this energy is reduced as the waves move closer to shore, such that by the time the wave hits the shore, it is estimated that it has lost 90% of its original energy. Therefore, to maximize recovery of wave power, wave power devices should ideally be located offshore, before the waves lose energy in shallower waters. This can therefore complicate significantly the supply chain and logistics issues surrounding the; locating, building, supply and maintaining the energy generating system when they are located a number of miles off shore.

2 CURRENT RENEWABLE ENERGY SYSTEMS – SUPPLY CHAIN ISSUES

The Carbon Trust's Marine Energy Challenge (MEC, 2011) estimated that 3 GW of wave and tidal stream capacity could be installed by 2020, generating approximately 8 TWh/y of electricity, which represents 2.1% of electricity supply in 2020. Estimates are that 7.8 TWh/y of this 8 TWh/y resource is near-shore and 0.2 TWh/y is shoreline wave energy. The MEC suggests that this capacity would constitute a substantial proportion of between 1.0 GW and 2.5 GW each of wave and tidal energy expected to be installed across Europe.

As is the case for wave power, tidal and current stream energies are both predictable and consistent. The MEC predicts more favourably that the UK possesses approximately 50% of Europe's tidal resource (compared to 35% stated by a government parliamentary report). The UK total resource has been estimated at approximately 110 TWh/y, with approximately 22 TWh/y, being technically recoverable, thus representing approximately 6% of the UK's electricity demand (Tidal Stream – Phase II, Marine Energy Challenge, 2005). In the short-term, the market opportunities for tidal turbine power have been forecast at a total capacity of 20.9 MW over the period 2004-2008, made up of 15.4 MW from tidal current turbines and 5.5 MW from tidal stream generators. In addition, the forecast for the UK was 17.4 MW out of the 20.9 MW total, or 84% of the total.

In order to realise the potential of wave power, it is critical that the UK energy sector ramps up the development and production of wave energy technologies. Court, 2008 states that it is likely that during the introduction of these sustainable energy technologies, some difficulties will be experienced in obtaining materials from domestic suppliers. In most instances, the market for renewable energy technologies is not yet mature enough to support established supply chains of any size. This may be related to uncertainties regarding the specifics of which materials are required, as much of the technology itself is developmental. Alternatively, the supply chains may be largely non-UK based, as is currently the case for wind turbine generators, for example.

In wind power, although the UK has world-class developers and consultants, there is currently very little manufacturing capacity in the UK and much of the value of wind-power projects goes abroad. There are no established turbine manufacturers and very few UK companies export components. However, the UK is home to both wind turbine rotor blade and tower manufacturing facilities of the world's largest wind turbine manufacturer. In addition, there are indications that with the increased commitment to wind power and with the large number of consented wind power developments, that UK based companies are positioning themselves to supply into this market, and there are certainly a considerable number of companies with the capability to do so.

For example, a UK based company is developing world-leading, direct drive turbine generator technology, and a UK based Research and Technology Organisation (RTO), with industrial partners, has developed radar absorbing materials which should see considerable global exploitation in wind turbine applications. The UK has established itself as an early market leader in marine (tidal stream and wave) power generation with approximately half of the world's current technology developers (approximately 30) headquartered in the UK. In addition, the UK has pioneered the establishment of shared facilities for the testing of wave and tidal devices.

In comparison, currently, there are few marine energy devices / technologies which have reached full-scale testing and, of these, the front-runners currently have, and foresee, no immediate materials

supply (chain) issues, as construction is largely utilising the UK's existing offshore technologies and know-how. The UK is very active in R&D for sustainable energy, through such initiatives as SUPERGEN, the Sustainable Power Generation and Supply Programme (<http://www.supergen-marine.org.uk/drupal/>).

3 WAVE & TIDAL ENERGY SUPPLY CHAIN DEMANDS

A large number, and a wide range, of companies are involved in the marine renewable sector, and Figure 1 shows the key segments of the sector. However, as mentioned previously, few projects have progressed to the pre-commercialisation stage and so, as yet, there are few common strategies for procurement and contracting. Different members of the supply chain are responsible for different parts of projects depending on the type of project and its stage of development. Key classes of firms that are involved in the supply chain include Legal firms, Financial firms, Insurance firms, Marine Service firms, Technology Developers, Manufacturers, Test Facilities, Project Developers, Installation Contractors, and Energy Majors/Utilities (Scottish Enterprise document).

Focussing specifically on the manufacturing elements of the tidal supply chain, the Marine Action Plan (2010) states that "manufacturers and relevant supply chain companies need to move in as quick as possible to take the wave and tidal technologies forward to deployment scale, for example, by helping to develop the commoditisation of components, with opportunities taken where possible to build on the UK infrastructure being created to support offshore wind developments".

Work undertaken on the Pentland Firth and Orkney project (Crown Report, 2011) identify the key supply chain issue as being that of Operations and Maintenance. It states that logistics costs and response times are reduced by carrying out a large proportion of maintenance activities local to each project, thus using local port facilities. If port facilities were shared between projects and able to accept complete devices for repair or refurbishment, then the scale of activity could attract a supporting supply chain with a clustering effect. Although the procurement models for O&M services are yet to be fully developed, it is anticipated that in early years, core activities may be led by staff based locally and employed by device manufacturers. This will aid feedback of design improvements to improve next generation devices. As the industry matures, more third-party providers could be expected to enter the market. Even for early phases, it is anticipated that providers of vessels and onshore component refurbishment and repair will contract with the manufacturers of a number of different devices.

The MEC, 2011 identifies the key supply chain issue of the need to drive research in to lowering the costs of components in existing devices, by working with supply chain companies involved in component manufacture, including major components such as generators. These 'Strand B' projects as they are termed are R&D projects targeted at key cost areas in order to drive down the capital cost of tidal equipment.

Marine Renewable (Wave and Tidal) Opportunity Review (2005) identifies a wide range of supply chain activities that are required to bring a tidal supply chain project to fruition. The supply chain activities range from Legal firms, Financial firms, Insurance firms, Marine Service firms, Technology Developers, Manufacturers, Test Facilities, Project Developers, Installation Contractors, through to Energy Majors/Utilities. It is the effective integration and successful inter-linking of these supply chain elements that are critical to a successful implementation project. Figure 1 shows the key supply chain players.

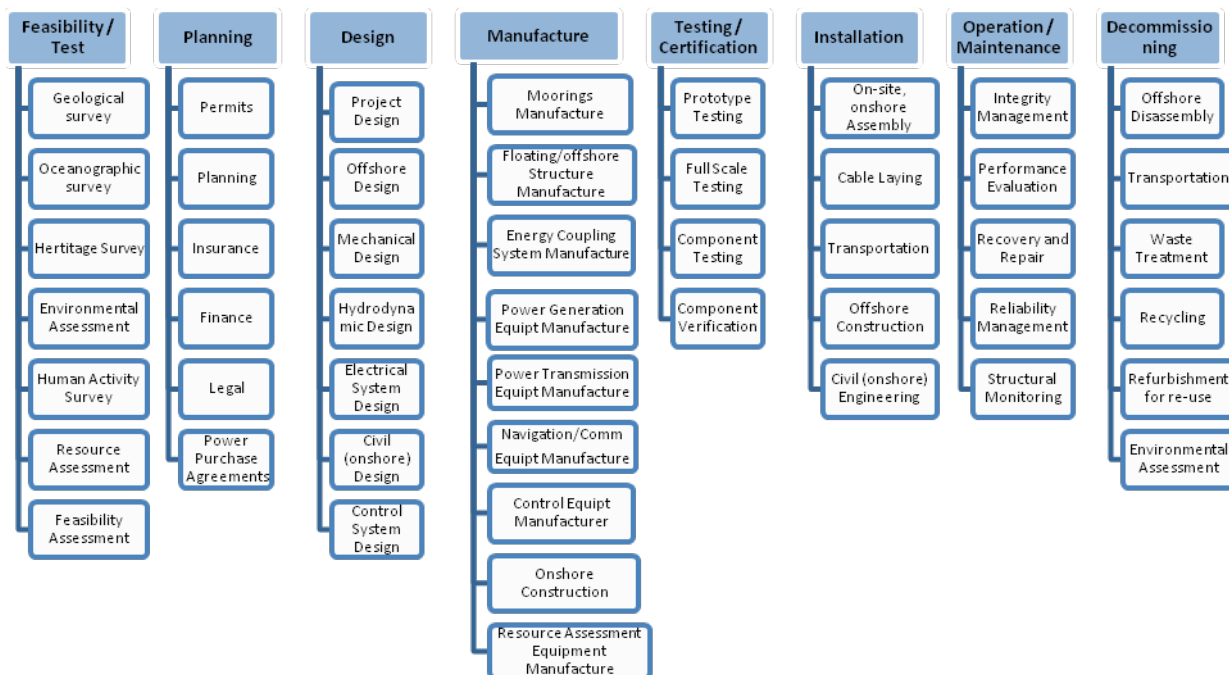


Figure 1: Segmentation of the Marine Renewable Sector (adapted from the Marine Renewable Opportunity Review (2005)).

From the review of this literature, it is possible to identify four Supply chain clusters namely:

- R+D Supply Chain (Design, Development, Test & Certification, Prototyping)
- Manufacturing Supply Chain
- Maintenance Supply Chain
- Decommissioning Supply Chain

3.1 R+D Supply Chain

This is a highly mature area of development in the UK with a number of leading academic/industrial collaborative projects being undertaken across different energy sectors such as wind, tidal etc (SUPERGEN Wind, SUPERGEN Tidal etc). The main thrust of SUPERGEN is the development of highly efficient tidal technologies and whilst there is work undertaken in financial and economic analysis, little real work is undertaken within this project that directly tackles the supply chain issues surrounding tidal systems.

3.2 Manufacturing Supply Chain

As is typically seen with new technology based projects, the development of manufacturing supply chains that are capable of supporting the development and implementation of tidal projects is seen as relatively mature in areas of the UK where tidal projects have been implemented and continue to run (Pentland Firth and Orkneys, Wave Dragon Project, Wave Gen Inverness etc). The supply of specific tidal and wave modules is also relatively mature with companies such as Marine Current Turbines (Bristol) and Pelamic Waves Power (Edinburgh). The component manufacturers providing specialist equipment to these power units is also developing where there is a suggestion that most are centrally located in the North of England such as Bendalls Engineering in Carlisle, Hystat System Ltd, Huddersfield and a number of companies in Scotland providing large scale hydraulic components and systems.

What seems to be the case is that many of these companies have adapted their manufacturing capabilities and knowledge from the experience gained in working on previous large scale wind turbine technologies and oil/gas projects. The companies are embedded in the energy industry and have made a side ways step towards developing tidal and marine based technologies and systems.

What seems highly evident here though is the need for supply chain companies to collaborate closely with the energy companies and academic institutions who are developing the specifications and technical requirements of the technologies required for the implementation project.

3.3 Maintenance Supply Chain

It is here that the greatest possibility for local supply chain companies to take a stake in tidal and marine energy systems exists. Projects such as Pentland Firth are relatively large scale energy production sites and are now moving in to the need to service and maintain their turbine units following periods of productive outputs under water.

The Pentland Firth project identifies a clear 25 year design life for the turbines and a 5 yearly refurbishment and repair programme for each turbine unit thus creating a rolling programme of work for which a strong maintenance supply chain infrastructure must be in place to support such a programme. It is estimated that by 2024 that over 900 turbine units will require onshore repair with some 500 of those units requiring full refurbishment. By 2024 refurbishment is expected to become a significant component of maintenance activity provided that the reliability of devices has improved in line with estimates. It is anticipated that due to the amount of space required, a mix of local and more distant facilities will be used. The estimates assume that a mean time between failures of five years is achieved by 2030 through a gradual improvement in performance from first installations, where there is a much higher chance of unplanned failure. These assumptions are based on long- term targets for the industry but there is significant uncertainty in how these devices will operate in terms of failure rates, particularly in the early years after deployment. There will be a variation in performance between devices, individual project conditions and approaches taken by the project developers.

Whilst the vast majority of the maintenance work being undertaken by the suppliers of the technologies in the first instance, more open competition is likely to exist in the future where local contracts for maintenance and repair will be awarded. It is therefore clear that the maintenance, repair and overhaul of tidal energy technologies will provide significant opportunities to companies in the future.

3.4 Decommissioning Supply Chain

Although discussed in a number of key documents, there is little specific detail available as to what and how the decommissioning supply chain will work. As with the manufacturing and maintenance supply chains, it seems that the decommissioning supply chain may be initially dominated by the major tidal energy technology companies who will have the knowledge base to support dismantling and decommissioning. Some of the experimental tidal systems are now approaching their end of operational life and as such, the supply chains surrounding decommissioning will start to develop and mature. This is an area of research that will require close monitoring.

4 PROCUREMENT STRATEGIES

Since few projects have progressed beyond the stage of technology developer led programmes, common strategies for procurement and contracting for large projects are yet to emerge. However, it is evident from consultation with suppliers that there are a series of factors that are considered when selecting suppliers for involvement on a project (Court,2008).

- Companies need to be known to the technology developer (often just through contacts formed at conferences) , or have a reputation in the marine renewable sector
- Companies with industry-recognised experts are favoured, even if the area of expertise is not directly relevant to the activities expected of the company.
- Companies which are large enough to support or assist in the project through the provision of additional resources are also keenly sought after (e.g. large generator manufacturers who are willing to undertake additional research/development activities if needed).

Initially (i.e. during development stage), suppliers are hand picked by developers based on reputation, experience in the sector and personal contacts. At full scale, contracts are put out to tender,

with firms that are known to the developer or have an established reputation in the renewable sector being those that are invited to tender.

5 CONCLUSIONS AND FUTURE RESEARCH DIRECTION

Scant information currently exists on the development of tidal supply chain systems. Since much of the work is currently developmental, much of the supply chain development revolves around the technology companies and larger tidal manufacturing firms.

The UK supply chain seems well positioned to play a major role in the supply chain in two areas namely; the R+D supply chain and the maintenance supply chain. Significant work is being undertaken in the UK on the Research and Development of tidal systems whilst the potential for growth exists in the maintenance supply chain as tidal production facilities move from their experimental stage through to full production. Therefore, the need for advanced monitoring of tidal turbine performance is required and responsive and effective methods of maintaining tidal turbine systems both in-situ and on-shore will be required.

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