

Tidal energy supply chains: do you want to dip your toe in the water?

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Abstract

The Research and Design of technology for tidal turbines is well established and at the point for many companies where systems need to go in the water. Therefore, the industry sector needs to change from a primarily technology research and development stage to a manufacturing and delivery stage. This however requires the supply chain to have the available capacity to ramp up supply in order to meet the demand needed for sufficient systems to be operational. Thus, a critical mass can be established generating the needed levels of energy to ensure a sustainable platform. The difficulty lies in establishing supply chain readiness with sufficient capacity in a relatively short period of time. This research looks at three key areas: those companies that currently engage in the tidal supply chain; those that have but not in any great capacity; and (arguably more important for growth) those that currently do not engage but feel they have something to offer. This paper looks at potential adaptiveness of company's products and services and their willingness to engage in the tidal supply chain i.e. diversifying their strategy and attitudes to risk.

1. Research background

This paper is based on a scoping study conducted as part of a longer-term project exploring the renewable industry's supply chain. Specifically, the work is seeking to determine the potential capacity for companies to be engaged in the renewable sector, along with a mapping of those already involved. To this end the study set out to address the range of interest from business and identify themes to be explored in future work.

With the UK obligated to meet the 2020 target of 15% of its energy requirements being delivered by renewable sources there is growing pressure to speed up the development of the renewable industry to enable sufficient capacity to meet target requirements. However there are reports that with 2020 just around the corner the UK will potentially fail to meet its target. The REA reported in June 2013 that "*The 2011-12 UK figure is 3.93% of energy from renewables, 0.11% short of the indicative target of 4.04%. The majority of the EU-27 had already met their 2011-12*

indicative targets by the end of 2011" [1]. Thus, if the UK is to get back on track, it needs to ensure a more rapid growth of the renewable sector with emphasis on increasing the capacity of renewable technology output. With the target in place the renewable sector has the interesting position of having a potentially guaranteed demand with a challenge to ensure the supply. Matching supply and demand is a classic supply chain management issue well researched and discussed indepth by a wide variety of researchers, Christopher and Towill [2], Fisher [3] and of course Forrester [4] to name a few. The overriding theory being to understand your market demand pattern and ensure your supply chain is robust and adaptive enough to efficiently supply the needed products or service to meet the demand. It is essential to have sufficient capacity within the supply chain to meet the needed market demand. Obviously determining future demand is never an exact science and forecasting is a key requirement but the renewable sector does know that it needs to grow its supply capacity to meet the needed 15% contribution by 2020. This offers an attractive potential for those companies in a position to capitalize on the opportunity. However, with 2020 only seven years away it has become a race of supply chain capacity development with huge competitive advantage for those that can mobilize their supply chain the fastest.

This research has considered that the renewable sector falls into four key areas: wind, solar, tidal and marine. Opportunity exists for all four categories, in fact it is understood that to meet the 15% target by 2020 that all four types of renewable technologies will be needed to ensure robustness of supply so a consistent 15% contribution is met. One of the key issues associated with renewable technologies is that they tend not to be sources of supply that can be relied upon 24/7. With a current lack of reliable, cost effective, energy storage supply is activated at the point of generation. In summary wind turbines are extremely useful so long as the wind is blowing, solar needs the sun; considered an unpredictable generator and certainly one that cannot supply at night.

The huge advantage for tidal technologies is that wave power is much more predictable than wind power and increases in the winter months when electricity demand is at its highest (Thomas et al 2013 need to add number for reference list). Added to this is the tremendous generating opportunity in the UK from wave, the Parliamentary Office for Science and technology stating in 2009 that the UK has approximately 35% of Europe's total wave resource [5]. This compares to the MEC who predicts that the UK possesses approximately 50% of Europe's tidal resource [6]. 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 [7].. So tidal can be an important, predictive stable supply source and therefore active provider of energy production to meet the needed 15% target.

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Equally development of this sector is not only necessary for the UK to meet its renewable target as there is a huge global market opportunity for those companies that can mobilize their supply chain and ramp up supply capacity. RenewableUK recently stated that commercial viability of wave and tidal technology is just around the corner and they predict the global market will be worth about £50 billion by the year 2050 [8]. The UK needs to continue its current engagement in this sector to enable it to capitalize on the opportunity and be in a position of competitive advantage. Development of the home grown supply chain would maximize the UK share of this potential global market.

Over the last 20 years industry has arguably been mainly focused on the market development of solar (especially via domestic engagement) and wind power generation however this research primarily wanted to explore the tidal technology supply chains and their potential readiness for rapid capacity growth to enable it to become a viable component of the energy supply infrastructure. The renewable Research and Development sector in the UK is mature and very active with initiatives such as SUPERGEN (the Sustainable Power Generation and Supply Programme <http://www.supergen-marine.org.uk/drupal/>). RenewableUK state "In wave and tidal energy it is vital to ensure that the UK builds on its research, development and leadership to secure a significant and long term supply chain base, as the sector moves towards commercialisation" [8]. Many tidal technologies are now available and companies are reaching the stage where they need the systems to go in the water. However, in order to do this the industry needs to ensure the supply chains have sufficient capacity.

Ramping up production will require rapid capacity growth in supply chains that have only been geared up so far to meet the needs of research and development rather than full scale production. It is recognised that there is currently insufficient capacity not only to meet the output needs to get enough systems in the water to both meet 2020 contribution requirements but also to enable the cost of the technology to come down (moving it from a unique product to a more mass production supply chain). The MEC in 2011 identified that in order to establish competitive advantage focus needs to be on 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 [6]. It is predicted that the tidal supply chain will need rapid expansion.

With lessons needed to be learnt from the growth of the wind and solar supply chains to be taken into account so mistakes aren't repeated. As stated by Thomas et al "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 [9]. There are no established turbine

manufacturers and very few UK companies export components.” Opportunities are available in the growing tidal and wave market but companies need to be in a position to capitalize on them thereby strengthening the overall supply chain. Equally in order to meet the 2020 targets the tidal supply chain capacity growth will need to be much faster than it was for the wind and solar sectors at the initiation of their entry into the market.

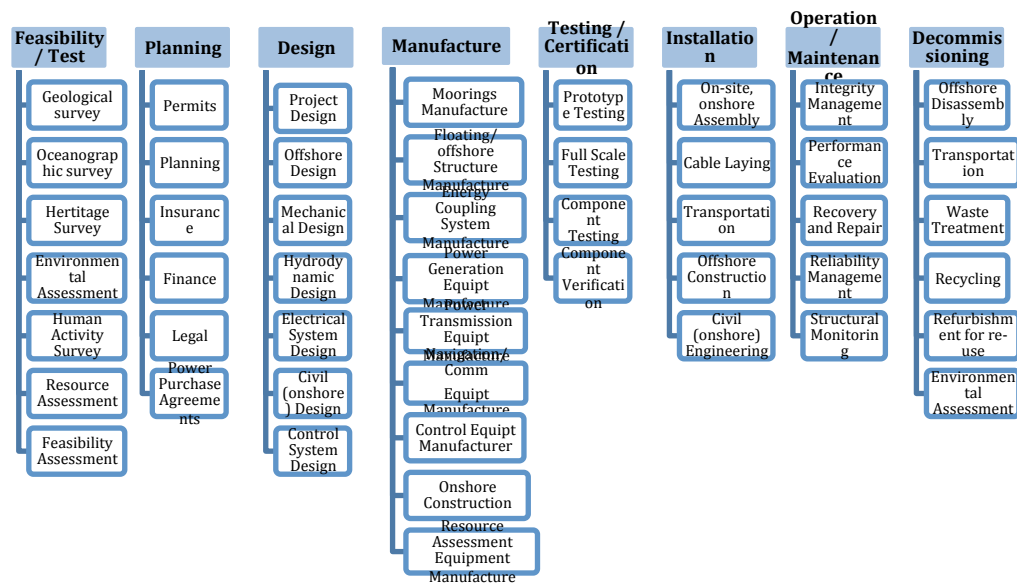
RenewableUK stated that “Wave and tidal energy represent a significant opportunity for the UK, not just in developing a new source of low carbon generation, but also in growing a new engineering and manufacturing expertise in the UK” [10]. However as previously mentioned in this paper, it is critical that the UK energy sector ramps up the development and production of wave energy technologies in order to ensure it is in a position to have a competitive advantage in the global market as well as the domestic market. In the initial stages of moving to a production phase for tidal and wave Court [11] stated that, some difficulties will be experienced in obtaining materials from domestic suppliers.

The main issue moving from the research and development stage into the full production and implementation stage is that in most instances, the market for renewable energy technologies is not yet mature enough to support established supply chains of any size [9]. However, as previously stated with the prediction of needed growth over the next 7 (in the short term) to 40 years the market may well need to mature very quickly therefore those that can establish agile supply chains with sufficient capacity requirements will be in a strong position to meet the supply needs. The gap between demand and supply potential will need to be filled so if the UK supply chains don't manage it then the supply chains may well end up largely non-UK based, as is currently the case for wind turbine generators [9].

The Marine Renewable (Wave and Tidal) Opportunity Review that was published in 2005 identified a wide range of supply chain activities that are required to establish a robust tidal supply chain [12]. These include service industries as well as core manufacturing companies. As with all competitive supply chains it is critical that effective integration and successful inter-linking and collaboration of these supply chain players are established, thereby enabling a robust and resilient supply chain [13]. Figure 1 shows the key supply chain players.

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Figure 1 Segmentation of the Marine Renewable Sector (adapted from the Marine Renewable Opportunity Review [12].



Interestingly the Marine Action Plan [14] which looked at primarily manufacturing elements of the tidal supply chain stated 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”. Therefore, growth is facilitated through adaption of expertise and skills from existing products and components so they can meet the needs of the new industry sector. Companies need to see potential opportunities in adapting their current products in order to feel comfortable to invest the time and resources making the changes needed. There are a variety of industry sectors that would seem to have expertise that could be adapted to the tidal supply chain primarily companies within the oil/gas and aerospace industries as well as large steel fabrication companies. Equally, experience and knowledge gained from working on previous large-scale wind turbine and structural projects could also be adapted. Therefore, rather than developing knowledge from the ground up companies could be encouraged and helped to make a sideways step towards developing tidal and marine based technologies and systems. Yet, there exists a risk for companies to diversify their activity into the renewable sector so it is important to be able to understand the factors that inform such strategic decision-making. Indeed, it is not only new companies to the sector but also those already engaged in aspects of the supply

chain for wind and solar that can be identified as having components relevant to the marine and tidal requirements.

2. Methodology

As a scoping study the primary aim of this initial work is to identify themes to be explored in greater depth in future stages. Thus, a detailed statistical analysis is not at the core of this paper. Rather the identification of significant aspects for further consideration is the principle aim. The study is based on a quantitative survey using a combination of multiple choice and likert scale questions. This approach was utilised as it presented a questionnaire that was quick and easy for the companies to respond to. The platform the questionnaire was developed on was survey monkey as this provided an effective platform, easily accessed by the companies taking part in the study. The layout of the survey was carefully set up so each page took up only the screen space to eliminate the need for respondents to scroll down as this again added an element of simplicity to the respondents. The questionnaire was tested on a variety of platforms such as computer, tablet and mobile phone to ensure it was laid out correctly and easy to use whatever device the respondents were utilising. Companies were targeted in conjunction with the South Wales Chamber of Commerce, employing their database of members. The structure of the survey was designed to identify those already involved in the renewable sector along with companies that may identify future opportunities. For a scoping study into tidal supply chain activity the 91 respondents, capturing a range of industry sectors, was a pleasing return. Results were then analysed and presented via pie charts and graphs.

The research needed to capture information about the current and future tidal supply chain. Therefore the study took the same approach as discussed by Lord Brown, based on the results of Offshore wind research carried out by the Royal Academy of Engineering in 2011 [15] who stated that the government should continue:-

- 1) to support UK companies already involved in the supply chain
- 2) engage with companies planning to become involved in the industry
- 3) explore opportunities for companies that are unaware of sector to enable gaps in the supply chain to be filled thereby to maximise capacity

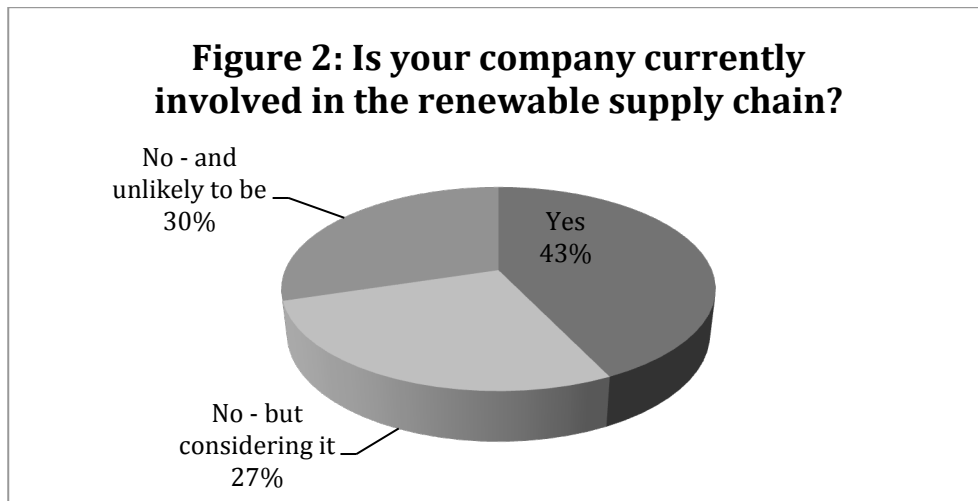
Given that the offshore wind industry shares many of the supply chain development and growth issues as the tidal and wave renewable technology sectors (including need to operate in an aggressive salt water environment) it was felt this research needed to capture information about the three streams in the tidal sector as identified.

The research conducted a survey via the South Wales Chamber of Commerce to study the current engagement in the tidal renewable energy supply chain. Therefore, this research was focused on analysing and filtering the information gained from companies sitting in the three key streams of interest: those that are currently engaged with the tidal supply chain; those that have a tangential involvement to the sector; and those that are tidal curious (a term introduced by David Clubb RenewableUK) but have yet to be involved. This will help to build a picture of the tidal supply chain from a variety of perspectives from those that are involved, have been involved and those yet to be involved. This initial study was also interested in capturing thoughts on whether barriers to involvement existed. The research also needed to explore whether companies know how to get involved if interested in engaging. The work covered in this paper is an initial study that forms part of a larger project looking to map renewable supply chain activity in Wales.

3. Findings and discussion.

The location of the majority of the respondents was Wales, to be expected due to the fact the survey went out to the South Wales Chamber of Commerce membership database, (only 2% of the respondents were located outside of Wales). The majority of the respondents were also SME's (97% were SME's), not unusual given the normal demographics of companies within a supply chain. 85% of the companies that responded to the survey have been in operation for 5 years or more so well established within their area of expertise.

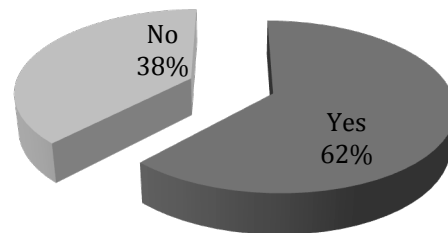
The first important question was looking at the key research objective of the study, which was to start to identify potential capacity of the tidal supply chain. This enabled an understanding of the three streams the study wished to explore, namely companies who currently are engaged in the supply chain, those who have dabbled in the past and those who feel they may consider getting involved in the future. Figure 2 presents the study's findings, 43% of the companies who responded to the study are currently involved in the renewable supply chain and even more interestingly for the expansion of the renewable supply chain capacity a further 27% stated while they are not currently involved they would consider getting involved. Thus, there appears to be an appetite to engage if the right opportunities are developed in market (and any current barriers to engagement are addressed). From this the key point for further exploration is what market conditions and or/opportunities need to be available to enable those companies to get involved in the supply chain and thereby develop the potential capacity.



In order to get a more specific understanding of the potential capacity in the tidal supply chain the respondents were asked to judge whether they felt there are business opportunities in tidal (stream and range) and marine (wave) renewables. For each the answers were similar with approximately 75% of respondents agreeing there were business opportunities available across all three sectors (stream, wave and range), thereby indicating a perceived opportunity. Given that only 43% are currently involved in renewables as shown in Figure 2, there are also a significant number of companies who are willing to become involved in the supply chain if the right opportunity presented itself.

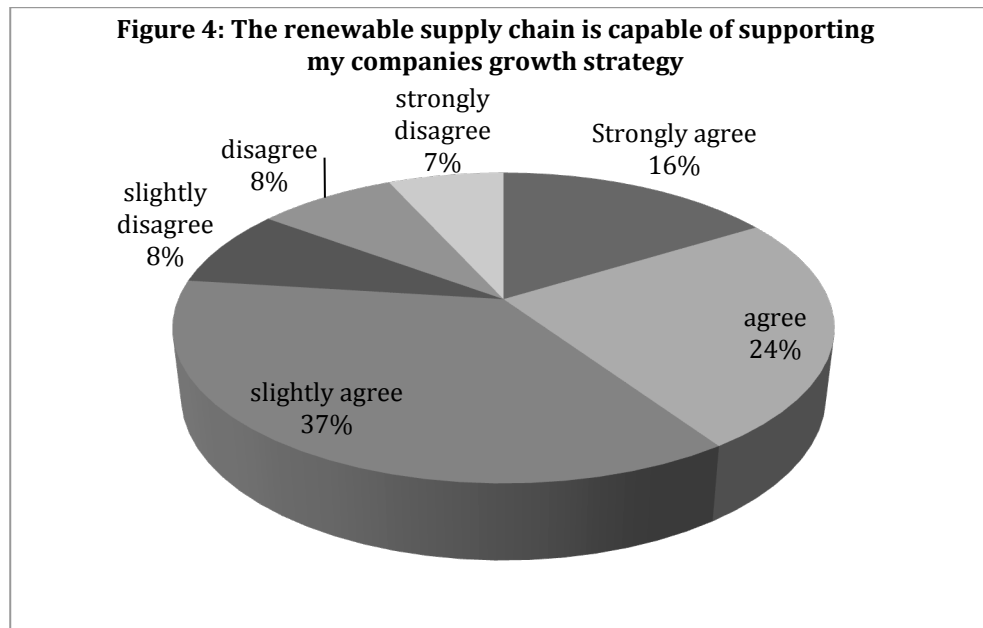
In order to explore the potential opportunities in adapting current expertise to deliver necessary products as services to the renewable energy supply chains companies were asked if they felt their technologies could be adapted, results shown in Figure 3. The majority of respondents stated yes they did believe they could adapt their expertise (62%).

Figure 3: Do you feel you have expertise that could be adapted to renewable technologies



Again this demonstrates a clear indication that given the right opportunities and collaborative development a majority felt they could adapt their expertise and technologies to meet the needs of the specific requirements within the renewable energy sector. Time required for adaption of expertise will be an important criterion to explore in more detail as the potential readiness of the supply chain assessment is needed if a proposed rapid expansion in capacity is in place to reach optimal levels of production.

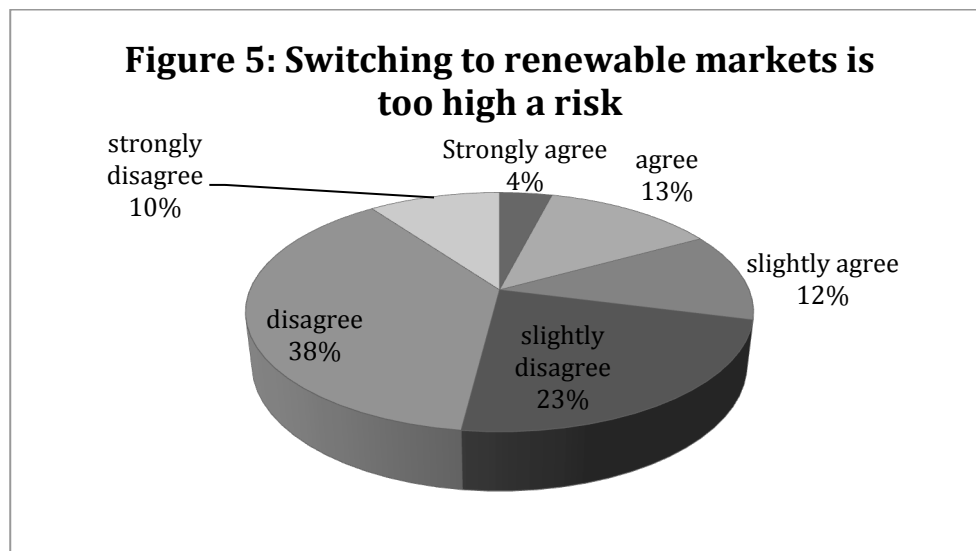
To explore perception of business potential the respondents were asked if they felt the renewable supply chain would support their companies growth ambition, the responses are summarised in Figure 4.



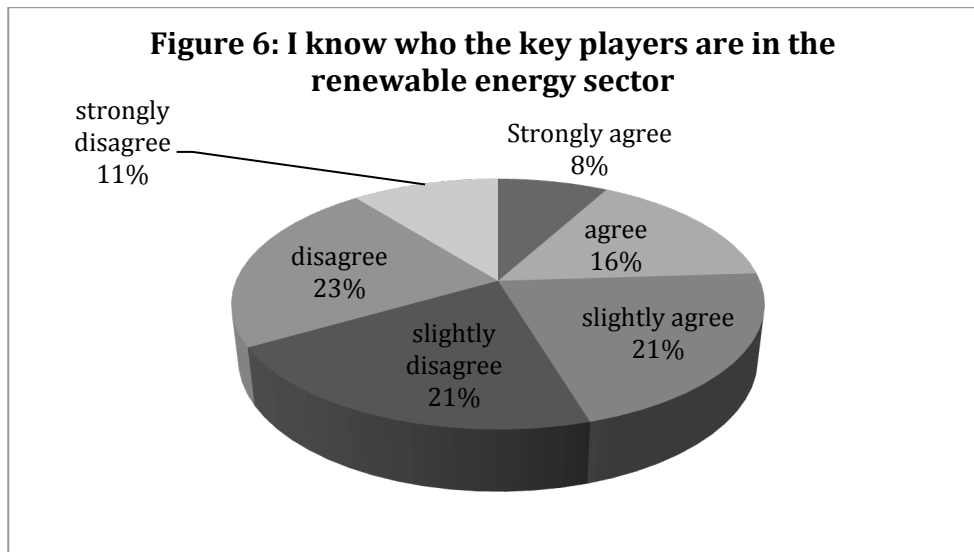
Again the results showed a belief there was opportunity to be explored with 76% respondents sighting belief in the growth potential. So if the right business environment can be allowed to flourish with careful handling of risk perception companies could be encouraged to become involved and therefore develop the necessary supply chain capacity. However, 36% only slightly agreed there was potential so there is obviously work to do to enable companies to feel there is a definite business opportunity to explore. Furthermore, there is a requirement to filter respondents to identify the areas of business activity that appear to see renewable energy as a viable strategic opportunity.

A feeling exists that there is still a perception of risk associated with developing opportunities within the renewable supply chain due to interpretation of stability of growth and the fear of the business opportunity not being sustainable in the long-term. Moving away from an impression that the renewables opportunity is project specific and therefore opportunity may disappear once a project is over needs to be addressed. Companies need to feel the risk is worth taking and that there is a long-term opportunity to be capitalised on before they will commit time and resources to adapting expertise to the renewable sector requirements. Thus, if the right opportunities can be highlighted and allowed to develop, companies will be able to see the opportunity for growth potential.

Therefore the issue and perception of risk is an important criterion when looking at ways to enable the development of the renewable supply chain. Thus, the survey looked at perception of risk in becoming involved in the renewable supply chain sector. However, when asked if they felt that switching to the renewable market is too high a risk it was encouraging that most respondents felt it was not. In fact only about 29% agreed there was an element of risk with 71% placing their answer on the disagree side of the scale as shown in Figure 5. Again though there is a note of caution as there does appear to be an element of insecurity with 23% only slightly disagreeing suggesting an element of sensitivity in the market where opinion may change either positively or negatively to short-term changes in the business environment thereby increasing the perception of risk level.



The key to engagement within the supply chain is of course having knowledge of who to talk to in order to find out information about upcoming opportunities and to ensure you are part of the business network. One of the barriers constantly being discussed is the issue of whether companies, especially those that have expertise that could adapt to meet the needs of the tidal supply chain, know about what potential opportunities exist and who to discuss them with. So, the research asked the respondents if they knew who to contact, the responses to this direct question are summarised in Figure 6.



What was extremely interesting was that just over 50% felt they lacked some knowledge of who the key players were in the tidal supply chain. Given that the research showed the majority of companies would like to get involved and yet a large proportion of them lacked the knowledge of who to network with, there would appear to be opportunity for capacity expansion if the right people are able to communicate to develop the supply chain and fill the current gaps. Before any significant development of the supply chain can be realised the lack of information of the tidal network will need to be addressed so companies that could contribute are able to be communicated with and be able to communicate to the network with the tidal supply chain. Indeed, this is a relatively simple barrier to address and strengthens the sense of latent opportunity that exists within the sector.

4. Conclusion

The initial survey results presented in this paper offer some interesting insights into the potential opportunities that exist within the business community to expand capacity of the tidal energy supply chain. Solutions will need to be found to enable the sector to play a key role in meeting the 2020 renewables target as the current supply chain capacity is known to be insufficient to meet the requirements of moving successfully to full scale production. The research has indicated that, as suspected, there are many companies who are not currently involved in the tidal supply chain who see potential growth and believe they have expertise that could be adapted to meet the tidal supply chain needs. However, there do appear to be issues surrounding perception of risk and willingness therefore of spending the time and resources to develop opportunities within a different supply chain. To

summarise, companies appear willing to diversify but they need to be able to see a robust long-term future to make the risk a reasonable one. One barrier that needs resolving before anything further can happen is the knowledge of who to contact in the tidal sector to explore commercial opportunities and move on to a point of initiation of engagement by many more companies. Greater understanding of the perceived risks and the root causes of the barriers need to be researched so the UK tidal supply chain can increase its supply capacity and be at the forefront of the global competitive market. Success in this will enable it to capture a sizable chunk of the global market of this potentially rapid growth area.

5. References

- [1] <http://www.r-e-a.net/news/official-figures-confirm-uk-off-track-for-2020-renewables-target>
- [2] Martin Christopher, M and Towill, D. R. " Developing Market Specific Supply Chain Strategies" International Journal of Logistics Management, Vol. 13, No. 1, 2002
- [3] Fisher, M. L., "What is the Right Supply Chain for Your Product?" Harvard Business Review March-April 1997
- [4] Forrester, J "Industrial Dynamics" Waltham, MA: Pegasus Communications 1961
- [5] Parliamentary Office for Science and technology 2009
- [6] The Carbon Trust's Marine Energy Challenge (MEC, 2011)
- [7] Tidal Stream – Phase II, UK Tidal Stream Energy Resource Assessment, Marine Energy Challenge, Issue 3, July 2005
- [8] RenewableUK <http://www.renewableuk.com/en/our-work/supply-chain/#sthash.KxfFH1S5.dpuf>
- [9] Thomas, A., Mason-Jones, R., Turner, D., Davies, P., Odoherly, T., Odoherly, D., Mason-Jones A., Murphy L., " Tidal and Marine Energy in the UK – Identifying the Future Challenges for supply Chain Development" IMCR Conference Sept 2013.
- [10] RenewableUK <http://www.renewableuk.com/en/our-work/current-priorities/delivering-long-term-support-for-wave--tidal-energy.cfm#sthash.RAotC9B9.dpuf>
- [11] Court S. A., 2008 "The mapping of materials supply chains in the UK's power generation sector, Materials UK Energy Review", NAMTEC Report
- [12] Marine Renewable (Wave and Tidal) Opportunity Review, Introduction to the Marine Renewable Sector, Scottish Enterprise, 2005
- [13] Christopher, M and Peck, H. "Building the Resilient Supply Chain" International Journal of Logistics Management, Vol. 15, No. 2, pp 13, 2004

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[14]Marine Energy Action Plan 2010, Executive Summary & Recommendations,
HM Government

[15]Royal Academy of Engineers.: Making Green Growth Real: UK Offshore wind
Supply Chain. Royal Academy of Engineers June (2011)