Maximising the Value of Marine Energy to the United Kingdom

Marine Energy Programme Board report
February 2014

Introduction to report

The Industry Today

Wave and tidal energy are the last two untapped global renewable resources, with an overall potential comparable to other major renewable resources. UK entrepreneurs, academic institutions and companies have invented, researched, developed and trialled the majority of leading technologies in this space. Many of these are now ready to make the move to commercial demonstration and deployment and the majority of the intended demonstration and commercial array sites are located in UK waters. All of this has been achieved because of long-term, solid and committed policy support from governments in the UK.

Through an analysis of existing research and a number of fresh case studies this report looks at the economic potential of the sector, while understanding how value from developing wave and tidal resources can be generated and retained within the UK. The case studies in particular offer examples of UK-level economic and employment benefits already achieved through reaching key sectoral milestones, as well as an understanding of what can be done to maximise UK 'size of prize' through technology development and deployment. Finally, conclusions are drawn on the necessary steps to ensure that the sector fulfils its economic potential.

Marine Energy: Our Vision for the Future

The commitments below reflect key priorities in wave and tidal technology development, in the context of strengthening the UK sector and increasing socio-economic benefits for the UK.

Sustainability: The leading parties in the wave and tidal energy sector are committed to building a sustainable marine energy industry in the UK, contributing a perpetual source of renewable, carbon free electricity to UK consumers.

Industrialisation: The sector is further committed to ensure that world class R&D in the wave and tidal sector, carried out in UK's academic institutions, research centres and test sites is fully commercialised enabling the UK to further reap the benefits of global leadership.

Economic Benefits: The UK industry recognises a once-in-a-lifetime opportunity to build a new energy sector which would deliver employment and business benefits within the UK by supplying the domestic market, as well as export abroad. The sector aspires to develop, where appropriate, the share of local economic content, by working with UK suppliers.

Cost of Energy: The industry sees sector practitioners, stakeholders and Government working together to ensure that the UK market continues towards large scale deployment, while ensuring that the experience gained in this process translates into reduced costs of energy and eventual parity with other renewable sources.

"The sector aspires to develop, where appropriate, the share of local economic content by working with UK suppliers."

Decarbonisation: the sector is committed to ensuring that wave and tidal energy installations contribute not only to the UK's 2020 renewable energy targets, but continue to be an important factor in reducing the power sector's carbon footprint to 2030, according to UK's domestic commitments and international treaties, and in accordance with the Climate Change Act 2008.

'Size of Prize': a case for continued public and political support for wave and tidal energy

The determination of a number of world-leading industrial nations to commercialise wave and tidal energy is driven both by the colossal energy yields estimated to be contained in the world's wave and tidal resources, and by the significant socio-economic benefits the development of this new energy sector can deliver to host nations.

The marine energy resource is estimated globally at over 120 gigawatts (GW) for tidal energy and 2,000 terawatthours per year for wave energy[1].

According to current estimates the UK could secure a marine energy industry (supplying a domestic and global market) worth up to £6.1 billion per annum, which would directly employ as many as 19,500 individuals and contribute GVA to the UK economy in the region of £800 million per annum by 2035[2]. Further estimates indicate that if the UK competes successfully in global markets to achieve market share contribution of marine energy to GDP could increase to 4 billion per year by 2050[3].

"The UK could secure a marine energy industry worth up to £6.1bn per annum, employing as many as 19,500 individuals and contributing GVA to the UK economy of £800m per annum by 2035."

Wave and Tidal Energy in the UK: key milestones reached

The UK wave and tidal sector has already achieved 5 important milestones. As stated earlier, this report examines a number of case studies detailing how the achievement of these sectoral milestones has translated into tangible socio economic benefits for the UK.

Key milestones are:

- UK companies, academic institutions, test sites and experts have led in an unprecedented drive to scale up wave and tidal technology and upgrade its technology readiness levels. The result is a world leading deployment programme with 13 devices currently in the water. See case study 1 on the European Marine Energy Centre (EMEC) below.

Case study 1: EMEC employs a total of 22 staff, and is self-supported by fees from device developers, as well as research contracts and consultancy. To date ~£33 million has been invested in the Centre by public bodies. A recent economic impact assessment carried out for Highlands and Islands Enterprise identified that the Gross Value Added (GVA) into the economy associated with EMEC to the end of 2011 was £149 million – a 4.5 multiple of the initial sum invested in EMEC. The economic analysis calculates that in the period 2003 to 2011, activity at EMEC supported the average equivalent of 119 jobs in Orkney and 262 across the UK – a figure that is still growing. Indeed, recent work for Energy of Orkney by Aquatera has identified 221 employed in marine renewables-related activity in Orkney alone in areas such as machine testing, environmental consultancy, marine operations, maintenance, design and research. This is a valuable contribution to a community with a population of 20,000, in particular because the employment is high-value, often graduate work, which is scarce in remote communities, and in addition because the expertise is being exported, bringing global revenues to the islands.

1 For global estimate of wave resource see numbers published by Pelamis Wave Power here http://www.pelamiswave.com/global-resource. For tidal resource see Marine Current Turbines estimate published here http://www.marineturbines.com/Tidal-Energy

2 Pg. 2, "*Channelling the Energy- A Way Forward for the UK Wave & Tidal Industry Towards 2020*", RenewableUK October 2010

3 Pg. 11 '*Technology Innovation Needs Assessment (TINA), Marine Energy Summary Report*', The Carbon Trust, August 2012, also available here http://www.carbontrust.com/media/168547/tina-marine-energy-summary-report.pdf

- Steps from R&D to full scale commercial deployment are already being taken. The first array sites have progressed through the planning system and received planning consent, with construction expected to start in 2014. See case study 2 on Pentland Firth Orkney Waters.

Case study 2: The Crown Estate has entered into agreements for lease for projects with a potential capacity of up to 1,600 MW in the Pentland Firth and Orkney waters. This followed a competitive leasing round for demonstration and commercial scale project sites which received considerable interest from industry. The Pentland Firth and Orkney waters is the first area in the UK to be made available for commercial scale development of wave and tidal energy. The projects are believed to represent the largest such developments worldwide. The leasing round was awarded Landmark Renewable Deal of the Year at the Ernst & Young Global Renewable Energy Awards in September 2010. According to a report by consultancy BVG the development of Pentland Firth and Orkney Waters has the potential to generate £6 billion of investment.

- For every £1 of public funding technology developers have been able to leverage £6 of private investment[4], demonstrating value for money and investment readiness. Amongst the investors some of the world's biggest technological and energy companies. See case study 3 and 4 on Pelamis Wave Power and Siemens/Marine Current Turbines below.

Case study 3: Established in 1998, Pelamis Wave Power (PWP) designs, manufactures and operates machines that generate electricity from ocean waves. PWP has its headquarters and manufacturing base in the Port of Leith, Edinburgh and currently employs 51 staff across its locations. Over the past ten years the company has attracted more than £40 million in private investment, £10 million in Government grants and has generated almost £20 million in sales. While a large proportion of the £70 million of funding the company has attracted has been from overseas, the vast majority of spend to date has been with suppliers in the domestic economy.

Both the existing P2 machines were manufactured at PWP's Bath Road facility in the Port of Leith. During construction of the P2 machines more than 80 full-time production staff were on site, including engineers, technicians and welders. Recent work by PWP shows that taking the full project CAPEX costs for the P2 projects over 80% of the spend was within the UK. Almost half the spend outside the UK was accounted for by the steel supply, principally due to UK suppliers/mills not having tooling to produce large enough plate. Assuming that a UK steel supplier(s) invest in suitable tooling to support larger scale manufacturing demand, PWP anticipates that as much as 90% of the CAPEX expenditure on next generation projects will be spent within the Scottish and UK supply chain. There is over 150MW of Pelamis capacity in development around the coast of Scotland: building this out to its fullest extent will likely take a total capital expenditure in excess of £750 million.

Case study 4: Marine Current Turbines Ltd (MCT), now owned by Siemens, has a pedigree in the tidal energy sector which can be traced back to IT Power Ltd in 1993. MCT has acquired factory space in St Philips, Bristol, which will be able to accommodate production volumes of the power conversion components for the SeaGen platforms way into the 2020's. The new 25,000 square feet facility will be the base for the development of next-generation drive trains used in SeaGen - the world's first and largest tidal turbine developed by MCT. The facility will be the first of its kind in the UK and will be used by the MCT team to assemble and test the first drive trains. The Bristol facility will be used for series production of the systems which will be deployed on the multi-turbine arrays e.g. in the Skerries and Kyle Rhea by 2016 and on other arrays beyond that. MCT is working closely with the UK supply chain to provide fabrication, assembly and installation services for the first demonstration projects with intent to develop strategic relationships with the proposed contractors for the larger UK market.

- The sector already employs over 1,700 full time direct employees, up from 800 in 2010[5]. These are in highly skilled 'green collar jobs'. See case study 5 on Alstom.

4 The investment ratio quoted has emerged from the case studies compiled for this report. For another example see Renews from 13th December 2012: "*Orkney-based Scotrenewables has clinched a foreign investment package of £7.6m... after a £1.24m WATERS2 grant from the Scottish Government*" published here http://renews.biz/29925/7-6m-pumped-into-tidal-turbine/

5 *Working for a Green Britain*', RenewableUK, September 2013, see also case study 6 below

Case study 5: Alstom are a large multi-national corporation, delivering a wide range of engineering solutions to the energy and transport sectors. They completed the purchase of Bristol based Tidal Generation (TGL) from Rolls-Royce in January 2013 having recognised it as one of the most advanced tidal turbine solutions. The TGL technology concept is now fully integrated into the Alstom Ocean business which is a part of the Alstom Renewable Sector. Alstom Ocean currently employs around 90 staff split equally between France and the UK. Alstom intend to develop their products to initially service both the UK and French markets. Alstom has, and will continue to, invest significant sums in R&D in the tidal sector that benefit local suppliers and continue to grow their business. But this can only happen on the basis that clear long term signals are provided to sustain the growth required to drive down costs.

Case study 6: In 2008 Renewable UK, the trade association representing wind and marine industries started tracking employment numbers in the wind energy sector on an annual basis. Marine energy statistics were added in 2010 at which point there were 800 employees in the sector. The next full survey completed on behalf of RenewableUK by Cambridge Econometrics, Institute for Employment Research and IFF Research registered more than a doubling of employees to 1,724. The research notes that these are full time direct employees, and further asserts that 91% of the jobs in the wind and marine industry are taken by UK citizens. The report goes on to offer a number of employment scenarios: in the high deployment scenario 676MW of capacity in 2023 generates 9,148 direct full-time employees (FTE) and 13,873 indirect FTE. In the medium deployment scenario 328MW capacity in 2023 generates 5,631 direct FTE and 6,476 indirect FTE.

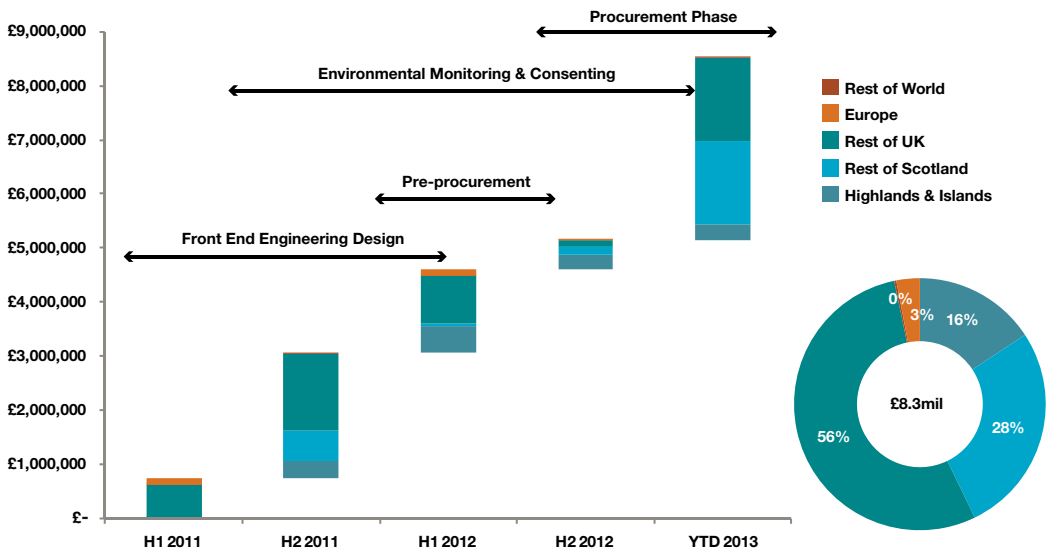
- A number of devices have proved their generation capabilities with the amount of electricity generated from wave and tidal historically in the UK now in excess of 10GWh.

In conclusion, case studies illustrate how in reaching key milestones the wave and tidal industry has delivered economic value for the UK.

Securing the future: 'size of prize' of sector development

As mentioned above, in addition to the milestones already achieved, this report identifies **5 key examples** of the socio-economic payback resulting from the continued investment in and the development of wave and tidal technology. To understand how these could be realised the report looks at range of examples from within the sector .

THE MEYGEN PROJECT: UK VALUE IN PREDEVELOPMENT



Case study 7: Aquamarine Power's proposed wave farm on the Western Isles could create hundreds of long-term skilled jobs in one of Britain's most remote communities. The Edinburgh firm's 40MW Lewis wave farm, which was fully consented by the Scottish Government earlier this year, could generate between 98 and 200 jobs during construction and inject up to £9 million a year into the Western Isles and wider Highland economy. The figures come from an in-depth assessment carried out by Aquamarine Power using a methodology developed by consultants ABP Marine Environmental Research and Risk & Policy Analysts Ltd to create an objective technique which project developers could use to identify the economic opportunity presented to the UK by the wave and tidal industry. Aquamarine Power's study showed that its 40MW wave energy project in the Western Isles could generate:

- 98 to 200 jobs per year in the Outer Hebrides and wider Highlands and Islands during the construction phase, generating an estimated £4.49 million to £9 million gross value added per year;
- 23 to 37 jobs per year during the 20-year operations and maintenance phase, generating £1.3 million to £2.1 million per year.

The first two Oyster devices have been almost entirely British-built, and the study confirms that future machines could be manufactured wholly in the UK, with the potential to source a hundred per cent of the farm's manufacturing supply chain within Britain.

- **Employment:** From a base of 1,700 employees today, the sector is expected to grow to 5,631 direct full time employees by 2023 and 6,476 indirect full time employees. As with the initial workers in the sector these will be highly-skilled jobs in the emerging 'green-economy', with a considerable share of UK workers
- **Local value:** Estimates based on current practice and comparable experiences indicate that even the first generation of wave and tidal arrays up to the 100MW built in the UK will generate multi-million pound benefits for the UK supply chain. See graph on *Meygen Project: UK Value in Predevelopment.* on previous page.
- **Exports:** According to estimates by the Carbon Trust successful technology development, and the required build of infrastructure and industrial capacity would enable the UK to successfully compete in global marine energy markets, contributing £4 billion per annum to UK GDP by 2050[6].
- **Regional Development:** The development of wave and tidal technology fits within the overall objective of encouraging regional economic development, where other development opportunities might not be available. Thus far, Highlands and Islands, Cornwall and North Wales have benefited from the deployment of wave and tidal and the first arrays are set to follow this pattern.
- **Wider supply chain benefits:** The UK already has a world leading offshore wind energy sector. Much of that expertise is complimentary to the development of the wave and tidal sector. By cross sector co-operation, the offshore supply chain could benefit from a bigger pipeline, while wave and tidal developments would benefit from the expertise and cost reduction potential.

Supply chain development: how UK industry is set to benefit from marine energy

The report outlines a number of case studies demonstrating the 'tonic-effect' of wave and tidal developments for UK industry and for local supply chain, detailing the economic positives mentioned above. Significantly, the report illustrates a pattern of development which benefits localities and local supply chains in particular need of investment. The report gives further indication of how these could be developed to the UK's maximum advantage. See table on Marine Energy Value Chain on page 6.

In the first instance, development so far has benefited UK research institutions, academic centres and technology developers. These were able to convert their leading position into a number of work programmes around international collaboration, knowledge exports, technology licensing and servicing international R&D programmes, as illustrated by the case studies in this report. As the UK example galvanizes other countries into action (France, Canada, South Korea) this segment of the value chain will continue to generate revenue.

Secondly, the opportunities gained through R&D operations and the running of demonstration sites has been converted into

6 Pg. 11 '*Technology Innovation Needs Assessment (TINA), Marine Energy Summary Report*', The Carbon Trust, August 2012, also available here http://www.carbontrust.com/media/168547/tina-marine-energy-summary-report.pdf'

Green: Significant UK lead. Actions needed targeted on protecting UK lead.
Amber: Opportunity at risk. Actions needed targeted at securing UK participation
Red: UK losing opportunity. Proactive interventions needed targeted at improving involvement of UK companies.

Marine Energy Value Chain

Research and development	Feasibility assessment, design and planning	Manufacturing and fabrication	Installation	Operations and maintenance	Decommissioning
• Technology development • Hydrodynamic and resource modelling • Geological understanding • Financial risk modelling	• Environmental consenting and licensing • Legal, financial and insurance services • Electrical and civils design expertise • Project design and management	• High value fabrication of power take off • Offshore structures and support structures • Energy transmission infrastructure • Components and monitoring equipment	• Novel installation and stationkeeping • Dedicated vessels • Cable laying and reinforcing • Onshore assembly • Offshore civils • Transportation	• Recovery and repair • Environmental monitoring • Integrity, reliability and performance evaluation • Marine operations	• Offshore disassembly • Refurbishment • Disposal • Environmental and legal compliance • Transportation

industrial supply chain benefits through industrial fabrication, installation and operations and maintenance at existing sites - again, as illustrated by the case studies. These are expected to yield further domestic and export benefits as the industry scales up domestically and globally.

In the third instance, knowledge gained during the scoping, licensing and consenting of the first arrays has been converted into consultancy knowledge exports and 'bankable know-how', which has been exported to foreign markets, as well as attracting foreign delegations and business to the UK, as illustrated. As the number of sites and experience grows, this part of the economy increases in value.

In the fourth instance, the specific challenge of building the first arrays is expected to drive financial investment in the sector, ramping up industrialisation, which will convert into local supply chain benefits, based on the progress made in the earlier steps. This should result in increased economic activity and employment, due to the proximity to a domestic market, as well as through exports and licensing.

"Building the first arrays is expected to drive financial investment in the sector, ramping up industrialisation."

Finally, a leadership position cemented through the preceding steps has long term strategic advantages. Market leaders are seen as important in driving standards, best practice, industry development, data aggregation, deal-making and facilitation and so on. This will enable the UK to derive the full gamut of industrial and service benefits from the technology.

Conclusions

As the wave and tidal industry is at the pre-commercial stage of development adequate capital and revenue support are the necessary preconditions for future growth, as is long term project-volume visibility. Other critical issues are consenting, commercial financing and grid, which all require joined up governmental thinking and wider stakeholder involvement.

When it comes to the particular issue of maximising supply chain value for the UK a detailed 'Sector Development Strategy' should be the next step. It could include the analysis of the following:

- track record and full value proposition of wave and tidal to the UK economy;
- applicability of lessons learned in other energy/marine/industrial sectors for the overall goal of maximising value;
- policy drivers and industry initiatives which would encourage retention and maximisation of value.

Such long term strategic vision for maximising value, resulting from a dialogue between industry and Government, could secure a thriving UK wave and tidal sector, fully delivering on its promise.