CATAPULT
Offshore Renewable Energy

Financing solutions for wave and tidal energy

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1 Executive Summary

This report is an analysis of the funding requirements and investment situation for the wave and tidal energy sector in the UK and suggests solutions that could facilitate the required investment to materially progress the sector. We have made some high level assumptions to estimate that, on its current trajectory, the tidal industry will need upwards of £100 million to get the first arrays to financial close. Additionally, we project that around £200 million of investment is needed to drive the wave industry along a path to commercial readiness. Further investment over and above these sums will be required for further tidal arrays and for the first wave arrays.

Funding for first arrays and technology proving has become less certain as investors have been pulling out of the market due to lack of clarity on future investment return potential and timing. The current investment challenges are reviewed, followed by insight on the status of, and interest by, potential investor groups.

From our assessment we clearly show that there is a lack of willingness from potential investors to invest in wave and tidal energy at the moment. The situation is becoming critical, as we have witnessed, with the UK Department of Energy and Climate Change (DECC) pulling a £10 million grant from what was to be one of the first tidal arrays. This market is strategically important to the UK but is on the brink of floundering. It is crucial that action is taken to bolster the prospects of the industry in order to get investors back in play.

We conclude by presenting several potential interventions in which the Offshore Renewable Energy (ORE) Catapult may play a role given its unique position as an independent centre of excellence with a mandate on wave and tidal technologies. The interventions include:

1. Benchmarking / stage-gating of performance for both projects and technologies
2. Purchasing of non-core (enabling) technology IP from leading wave tech developers for development and usage by the rest of industry
3. Coordinated and syndicated public and private funding and support for technologies to de-risk investment. Investment would be coordinated with and contingent upon technology stage-gate assessments
4. Coordination of due diligence for both projects and technologies
5. Contingent loan facility for first arrays

2 Background

Globally it has been estimated that up to c.240GW of marine capacity could be deployed by 2050 with about 75% coming from wave[1]. The Carbon Trust estimates that the UK could capture about 22% of the accessible global marine market in the period 2010-2050 and this would be worth around £76bn (cumulative, undiscounted)[2].

Wave and tidal energy technologies are still in the development stage with low levels of deployment to date. The levelised costs of wave and tidal energy[3] are relatively high compared to other renewable energy sources. Assuming wave and tidal energy costs can come down via technology innovation and maturation, there is potential to extract approximately 50 TWh/yr of wave energy and 20 TWh/yr of tidal energy from UK waters[4].

Effectively harnessing this large, indigenous resource will unlock major benefits to the UK including greater security of energy supply with a lower carbon intensity and material economic growth; Government is therefore keen to promote advances in these technologies. Government has put policies in place to create a more attractive market for this embryonic industry. This includes the Contract-for-Difference mechanism as part of the recent Electricity Market Reform, a market-based solution to channel grant funding to the relevant technologies and technology components.

In addition to Government support for marine energy, there is a strong need for private sector investment over the next few years alongside the available public sector support as these technologies move towards commercialisation.

The gap between the technology readiness for wave and tidal has widened in the past few years: tidal energy devices have been through the proving stage and are now coming to the point of contracting the first demonstration arrays, while wave technologies are still at the device proving stage. As a result, different interventions and support are required for each.

The marine energy supply chain is in its infancy. The notion that oil and gas suppliers can kick start the market is not easily realised because products from oil and gas are too expensive, as they have been designed to operate at extreme depths, in benign tidal flows, and low oxygenated waters. Developing a supply chain that understands the market and is then prepared to invest and support the non-core enabling technologies is essential for the success of the overall industry.

[1] Energy Technology Perspectives. IEA, 2010
[2] Green Growth Paper. The Carbon Trust, 2011.
[3] Levelised cost of energy is the discounted full capital and operating costs for an energy generation source over the source's life time, including the cost of capital, expressed per unit of energy delivered (£/MWh).
[4] Accelerating Marine Energy. The Carbon Trust, 2011. Available at https://www.carbontrust.com/media/5675/ctc797.pdf

3 Funding requirements - Tidal

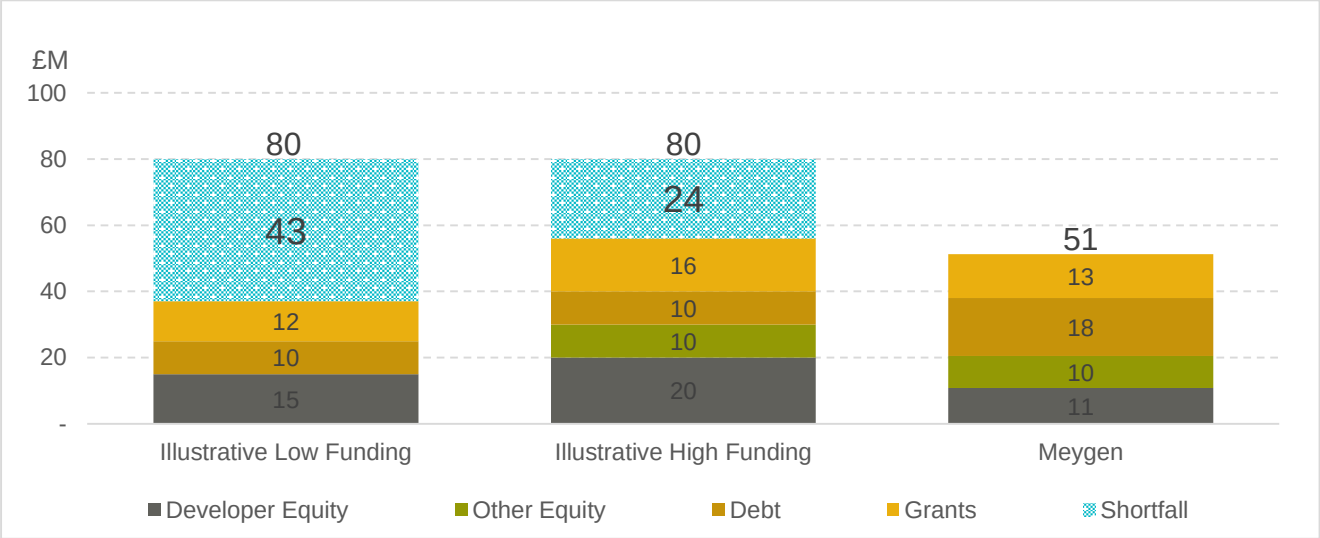
Today's front-running tidal device technologies are considered close enough to commercially ready devices to create sufficient confidence for utilities to move forward to the first array stage. For tidal energy, there are four demonstration arrays seeking to reach financial close in 2014 and 2015. The future of the tidal industry is dependent on the outcome of these first arrays; the success of which is critical towards attracting additional funding into the sector. In September 20134, Atlantis Resources Ltd announced funding has been secured for the next phase of the Meygen Project in the Pentland Firth; £51M has been secured for the installation of 4 1.5MW devices, with First Power planned for H1 2016. The Meygen funding breakdown is shown in Figure 1 on the following page and includes both debt and equity from Scottish Enterprise's REIF – we have assumed in our analysis that only debt OR equity will be available from REIF for future projects.

Looking at a typical project, we estimate that between 30% and 54% of the required funding has yet to be secured in some cases. The need for private sector funding in these initial tidal array projects is urgent. The public sector funds that have been allocated are conditional upon securing private sector investment as well. Due to the nature of public sector budgets periods, the conditional funding has an expiration date, as we have just seen with DECC pulling back £10 million it had provisionally allocated to the Marine Current Turbines (MCT) Skerries project.

In addition to government grants, two of the leading projects are likely to receive a £10 million investment loan each from The Crown Estate. This investment is likely to be structured as a hybrid of grant and debt. With still a significant amount of projects funding yet to be secured, project developers themselves are taking significant equity shares in their projects. Project developers, typically either utilities or technology developers in the case of these initial tidal arrays, are not willing to contribute the full funding required as a means to gauge and ensure interest from an end-market. Estimating that project developers are able to invest £15 to £20 million of their own funds into a project and obtain a mix of debt, grant and further equity funding, as we have done in Figure 1 below, there remains between £24M and £43M of project costs to be funded, assuming a 10 x 1MW turbine array with costs of £8M/MW.

If we assume that the remaining three initial tidal arrays require a similar amount of funding on average, then in the range of £72M to £129M is needed to get these arrays to financial close. There is a dearth of investors willing to take on the risks and unknowns (namely the short and long term performance and returns) associated with these projects, thus project developers are looking towards the public sector to facilitate funding solutions.

Figure 1: Illustrative project funding structure for first tidal demonstration array of 10 MW



4 Funding requirements - Wave

Looking at the wave sector, leading wave developers have demonstrated at the same full scale at EMEC. However further technology development is required to demonstrate truly commercial devices which provide high confidence in performance and survivability, and potentially to reduce levelised cost of energy (LCoE) that utilities and project developers require to move forward with first array projects. Based on discussions with industry experts, estimates of the investment needed per company are roughly on the order of £50 million over five years to bring semi-proven devices (i.e. devices proven at part scale) to the end of a full scale demonstration. Ideally two to three wave technologies would need to secure this level of investment spread over five years, c. £150 million, in order to develop a robust and competitive wave energy industry that can drive down the costs of the technology towards commercialisation. This assumes that the devices and their enabling technologies are developed in isolation. However potential cost savings from coordination of enabling technology development could reduce this £150 million requirement.

Tidal technology

Tidal stream technologies have progressed further towards commercialisation than wave technology, largely due to better understanding by and investment from large original equipment manufacturers (OEMs) such as Siemens, Rolls Royce, and Alstom. Investment by these OEMs has enabled these technologies to undergo the testing and proving necessary to get these first generation devices ready for installation into first arrays. In some instances, out of necessity as a means to prove their technologies, OEMs have also had to take on the role of project developers as well, as in the case of the two Siemens MCT projects. One project is being sponsored by utility Scottish Power Renewables and one by MeyGen, a project developer owned by device developer Atlantis Resources Corporation.

The public grant funding that has been agreed in principle is reliant on securing the match funding from private sources. In some cases it risks being recalled if projects do not reach financial close within the funding deadlines. The main challenge to bringing in other investors and funding has been that both technology and project designs continue to be updated causing investors to seek further rounds of due diligence before committing to investing. This delays projects from reaching financial close.

One of the four initial tidal arrays involves a utility in contrast to the offshore wind industry where the majority of projects in the UK are being sponsored by utility players. To date, a handful of utilities have invested in some wave and tidal technologies incentivised by government policies. However, underperformance in core business areas of the utilities and development delays reducing the prospect of returns from marine energy initiatives, have meant that these initiatives have had to be scaled back or divested.

OEMs are likely to continue to be key investors in tidal energy development however there are limits to how much exposure OEMs can have to individual components or devices. The OEMs are exposed to the risk of R&D failure by investing in new components and devices. The provision or extension of warranties for OEMs' products, which is generally required by project owners, represents another risk for OEMs to bear. To some degree these risks inhibit further innovation.

Private sector investors are nervous about whether projects will deliver a high enough return to justify the risks of investing particularly given the variety of unknowns surrounding array performance, which will be comprised of devices which in most cases are still being tested and where only a handful of device installations have been undertaken.

Capital requirements will need to be reassessed whether or not initial arrays reach financial close this year. If investment is not secured, public initiatives will continue to be relied upon to take the lead, however they alone will not be enough. If investment into arrays is to continue, new sources of private capital for larger, more commercial arrays will need to be found.

Wave technology

It is clear that the involvement of major engineering companies has allowed tidal technology developers to progress towards commercially ready devices more quickly than wave technologies. More needs to be done to enable the leading wave technologies to foster the same transition from technology to product. At this point, the leading wave technologies are still proving their prototype devices and thus are reliant on investor types with a high risk tolerance and a familiarity with pre-commercial technologies, such as venture capital (VC) funds. However there is a poor fit between VC funding models and the current returns profile and length of time for wave technology to make returns.

Early VCs who have invested in the wave energy sector have lost out, and Government and corporate support, a key factor in VCs' decisions to invest in the sector to begin with, has not been as forthcoming as first anticipated.

OEMs can be more patient in the wait for returns than VCs and may invest in risky technologies for strategic reasons if there is a good fit with their own capabilities. However, both VCs and OEMs have entered and then exited from the wave sector in recent years, frustrated by the lack of progress and returns. Furthermore, wave technologies are difficult for investors to understand and accurately assess because devices are complex and quite dissimilar across the sector.

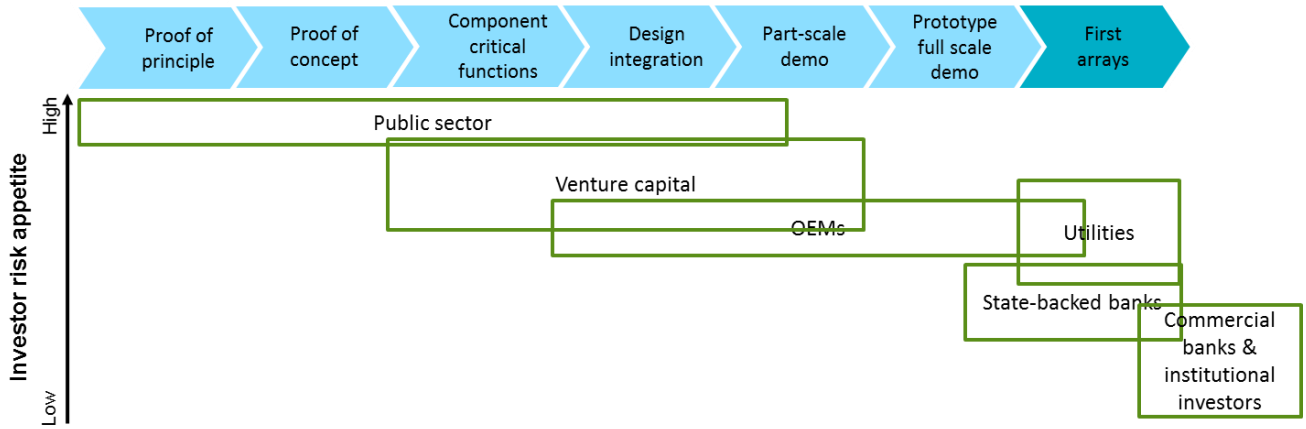
The leading wave technology developers are not only struggling to gather private sector investment but, as first movers, are burdened with the development of all enabling technologies and components required for first arrays. Given the disparity of wave device designs within the wave energy sector, the tendency has been for bespoke solutions, leading to significantly

increased costs as compared to the tidal sector where more standardised or generic components have been available.

5 Potential investors

Any potential investors from the private sector need to see continued government commitment to their support regimes (CfD and grant funding for innovation and cost reduction) as a means to gain comfort with these markets and reducing the political risk to a minimum. Potential investors in initial tidal arrays and commercial wave prototypes will be those with higher risk appetite and a good understanding of technology. Figure 2 below maps out investor types by their risk appetites and the investment returns they seek. After public sources of funding, those with the highest risk tolerances for marine technologies include utilities, OEMs or supply chain companies operating in the space, and venture capital funds.

Figure 2: Investor type by risk appetite and technology readiness



5.1 Public sector

Given marine energy's early stage of development, direct public grant funding is the most important source of investment in these technologies. At present the public funding landscape lacks coordination as grant funding becomes available in spurts from a variety of governments and government agencies: funding to date has been focused on overcoming specific hurdles which has driven R&D in a stop-start manner. There is no clear line of sight on the future of public support which would work to bolster the private sector's confidence in the industry and make it easier to attract the matching private funds. The sporadic manner in which public funding has been provided has left gaps within the technology development journey through which companies need to travel to reach commercialisation. There is a need to streamline and coordinate the public funding, at the global, European, and UK level, to bolster private sector confidence in the market.

5.2 OEMs and supply chain

OEMs and companies involved in the marine energy supply chain understand the risks inherent in technologies and array projects better than any other potential investor class out there; they also incur the most direct losses if projects do not go forward. For this reason, we have seen

instances of OEMs leading the project development (e.g. MCT Siemens) in order to create a route to market for their device.

The role for this category of companies is one that has diverged between wave and tidal. The leading tidal energy devices have received investment from OEMs which has strengthened their testing regimes, bolstered confidence in the technologies themselves, and importantly provided a longer term funding horizon. While OEMs are well placed to develop the technology itself, they are uneasy project developers and owners, partly because this is not a sustainable model. Ultimately they are likely to find the risk of developing the technology and the array projects too much for their balance sheet to handle. Supply chain companies understand the details of these projects and have an aligned interest in project success, however their business models do not lend themselves to investment in the project itself.

Wave technology companies require the backing of large OEMs with expertise in volume production, working offshore, design analysis, supply chain links, and testing experience, in order to accelerate the component and prototype testing. However up to this point, OEMs have found tidal technology a less risky proposition in which to get involved. The route to market for wave energy technology is less clear and thus OEMs that have invested in wave technologies have stepped back, finding these investments unnecessary for the moment. OEMs would need to see a clear route to market in order to regain interest in the wave energy market.

5.3 State-backed banks

There is an important role to be played by state-backed banks that are able to take on more risk than commercial banks in order to attract additional investment support. This is the case for the UK's Green Investment Bank (GIB) which, while it operates on fully commercial investment terms, has the mandate for its investments to be additional, i.e. investment in projects in which it gets involved would not happen without it. First arrays and commercial projects using innovative components, would be examples of where the GIB could get involved, provided adequate projects returns could be forecast to warrant the risk.

5.4 Utilities

Utilities have invested in both technology developers and initial stage of array projects as a means to keep abreast of the technologies. However, given the delays on returns from these types of investments, particularly for wave energy, and underperformance in other areas of the utilities' operations, utilities have recently been divesting their marine energy portfolios. This has led to some challenges since a number of the public sector innovation support programmes were predicated on continued utilites involvement. Utilities typically do not involve themselves in funding high risk, early-stage technology development as ideally they should be the end-user of marine energy converters rather than investors. However, if risks could be mitigated, or more confidence gained about likely performance, utilities may consider investing to drive further development given their vested interest in the sector and, by doing so, crowd-in other private investors who would see a clearer route to market.

5.5 Commercial banks

Commercial banks are highly focused on the return on their investment and are unlikely to get involved in the first phases of arrays. Involvement of the GIB would be required as a means of getting commercial banks to invest in tidal projects.

5.6 Venture capital and private equity

Venture capital funds have entered and exited the marine energy industry largely via investment in technology developers. There is an important job to be done to rebuild and regain these investors' confidence in the markets once the time to market is sufficiently attractive and there is a track record on returns.

Venture capitalists, a potentially significant source of capital and with investment risk profiles which lend themselves towards investing in earlier stage technologies, need to see a track record of development and progression. Venture capital is unlikely to 'go first' in investing in new or further devices. Investors need to be convinced that existing funding, including further public support, is committed to bringing devices to full scale demonstration. It is important that VC investors see a clear route to market within the timeframes they seek to secure returns, which is currently not the case for marine energy.

Generally VC's seek to exit investments after three to five years. The VC funds that have got involved in the wave sector have generally done so for strategic reasons, such as being the venture arm of an OEM (Alstom Ventures, ABB Technology Fund) and have relaxed their investment time horizon. However, even with relaxed expectations, VC firms are not seeing returns from this sector and are growing frustrated. The leading wave energy technologies after five to ten years of development are still several years away from generating returns, and the capital costs are proving to be much larger than anticipated.

Given the way their funds are structured, private equity players are return driven and are likely to invest in companies along the supply chain rather than at a project-level. To date, private equity has invested in some related supply chain companies, such as vessels, for offshore wind turbine and foundation installation. This is based upon top down assessments of industry and project needs, e.g. a bottle neck in the supply chain for jack-up vessels. Increasing familiarity with the wave and tidal energy markets and supply chain could help bring about private equity investment into companies involved in the marine energy space, bolstering innovative technologies and solutions, and thus bringing down the levelised cost of energy.

5.7 Institutional investors

For array projects, institutional investors are likely to be a step behind commercial banks in terms of comfort investing in this type of project. Involvement of commercial banks would signal to institutional investors (such as pension funds) that these projects are bankable and starting to

meet the investment criteria that commercial entities require. The long-term investment time frame of pension funds is well suited towards investing in this type of project.

Other types of institutional investors that require higher liquidity/shorter time horizon for itheir investments, such as energy-specific investment funds and the large Japanese investment conglomerates, are starting to look at the wave and tidal supply chain for investment opportunities. This includes vessels, engineering consultancies and installation companies - similar to investments made by private equity funds.

6 Investment Challenges in Summary

As we can see, there is a lack of willingness from potential investors to invest in wave and tidal energy at present. The situation is getting critical, as we have witnessed with DECC pulling a £10 million grant from what was to be one of the first tidal arrays. This market is strategically important to the UK and is on the brink of floundering. It is crucial that something is done to bolster the prospects of the industry in order to get investors back in play. Despite their reluctance to invest at the moment, the above mentioned investor groups will have a key role to play when their risk and return profiles start to align with the prospects for marine technologies and array projects.

7 Getting investors comfortable with marine energy

When identifying solutions to engage investors in marine energy we have looked at investment at the project level for tidal energy and at the technology developer level for wave energy, given that wave and tidal sectors are at different stages of development.

7.1 Tidal energy

Some of the main challenges facing the first tidal array projects are:

- Difficulties in presenting a clear picture to investors on the development level and performance expectations of the technology;
- Coordinating due diligence across investors, particularly as projects continue to evolve after investors first agree to invest; and
- Inability to guarantee adequate performance of array projects and thus the return on investment from electricity generation.

7.2 Wave energy

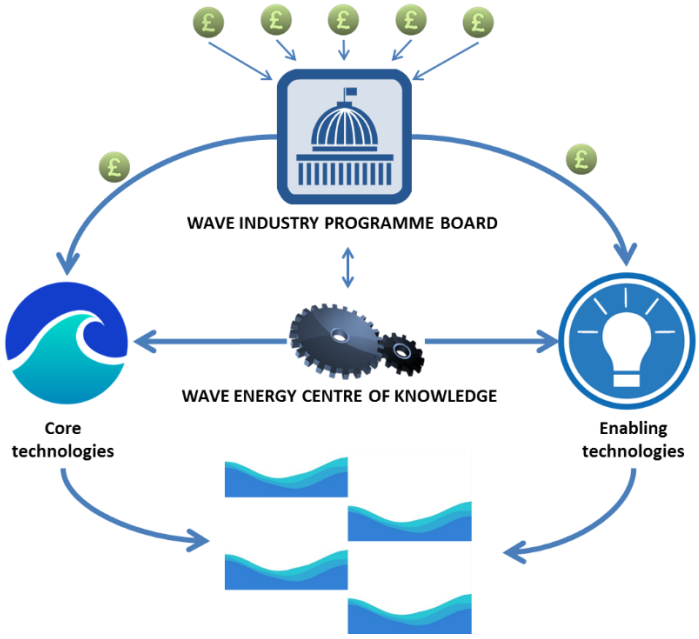
The main challenge in the wave energy sector is that early stage devices are not attracting enough overall support to take development through to full scale demonstration. Key underlying reasons for this are:

- Incompatibility of funding requirements, returns, and investment tenor between wave energy devices and venture capital investment models;
- High costs of technology development, exacerbated by leading developers spending multiples of the cost of just core technology IP on enabling (non-core) technologies as well;
- Poor coordination of investment and public sector funding; and
- Lack of understanding or interest in the technologies themselves by potential investors.

Potential interventions to address these challenges are outlined below.

Intervention	Rationale	Impact
1. Benchmarking /stage-gating of performance for both projects and	Benchmarking, or stage-gating, of technology devices would have an important impact on investment into the sector. The stage-gates would be promoted to both public and private investors, including OEMs, utilities, banks, and venture capital funds.	Enables investors to more clearly understand the state of development of the technologies and projects seeking

technologies (wave & tidal)	This will provide higher confidence in which technologies have a higher likelihood of commercial success and could enhance understanding of performance for better modelling of generation and project returns.	investment. Also will impact understanding of performance to better understand project returns.
2. Coordinated and syndicated public and private funding and support for technologies to de-risk investment. Investment would be coordinated with and contingent upon technology stage-gates assessments (wave focus)	This would involve a syndicated pool of funds from public sources initially with a view to instil confidence into private sector investment in the longer term. The coordination and aggregation of funds across multiple sources into a single entity would coordinate and streamline funding, and ensure investment reaches critical scale in individual technologies/devices. Devices would progress through development phases by reaching specific stage gates which would allow the technology to unlock additional funding. This verification process could result in a potential ORE Catapult stamp of approval certification to de-risk technologies and alleviate investor concerns. Private sector investors contributing to the fund would benefit by spreading investment risk across multiple technologies rather than undertaking the due diligence necessary for and risks involved with individual investments.	Progression of energy devices (focus on wave) towards commercial readiness and investment by OEMs, utilities, and eventually other investors. Provides confidence to developers and investors that funding will be available through to commercialisation.
3. Initiative to access enabling technologies from leading wave device developers for development and usage by the rest of industry (wave focus)	Leading wave technology developers have been forced to develop enabling technology components and knowledge out of necessity to drive and facilitate a-market for their devices. The costs of the non-core technologies are estimated to be up to four times as much as the cost of the core technology IP. An initiative whereby enabling technologies were licensed from the leading technology developers for development and usage by industry could streamline wave technology development. The remaining industry, including newer wave technology devices, could access these enabling technologies and avoid having to develop them on their own. This could save them up to 4x the costs undertaken by the leading wave technology developers.	Streamlined/reduced cost of technology development by removing need for each wave technology developer to develop non-core technologies in tandem with their core IP. Allows the industry to access enabling technologies which will quicken pathway to first arrays and facilitate standardisation. Also, spreads risks by accessing experts in the field for each given technology component.

		
4. Coordination and standardisation of due diligence for both projects and technologies (wave and tidal)	ORE Catapult works with project investors to agree upon standardised and coordinated methodology of due diligence process for marine energy technologies and projects. This is particularly relevant for investment in new wave devices and coordinating and aligning due diligence for early tidal arrays. ORE Catapult is currently undertaking a project to develop a stage-gated assessment process for technology development which can be coordinated with or become part of the due diligence process for technologies.	Enables investors to more clearly understand the state of and potential project returns for projects seeking investment, particularly when multiple project partners, devices, or consortia of investors are involved. Provides engineering robustness, ensuring that technologies 'get it right' rather than just chasing pockets of funding.
5. Contingent loan facility for first arrays (wave and tidal, though tidal focus)	The contingent loan facility can be based on a pool of funds from various sources (e.g. various government agencies) to reduce risk from those supporting this loan facility. This could be on the order of £5-6m, available to help service debt in the event of business interruption, for example due to a machinery breakdown. There are several ways to structure this contingent capital, such as via a loan facility or options on preferential shares having the same net effect as a loan facility. The technical criteria for distribution of funds is the most critical part of this. Such a loan facility can be integrated with stage-gated proposal, in that specific stage-gates are required to trigger the loan facility, for example.	Works as an insurance policy to guarantee returns to service debt in the event of technology failure/breakdown thereby reducing risk to potential project investors as it means that project continuity will not be put in jeopardy due to business interruption.

	Key players for this intervention: pool of public funds, coordinating body for distribution and gate-keeping for the pool of funds, insurers.	

8 Conclusion

The lack of investment in the wave and tidal industry has brought the marine energy industry in the UK to a critical juncture. It is crucial that something be done to strengthen the prospects of this strategically important industry in order to get investors back in play. The investor groups identified above will have a key role to play in the future when their risk and return profiles start to align with the prospects for marine technologies and array projects. The time to act in order to create the supportive information and structures that will facilitate investment is now.

The ORE Catapult is well placed to engage with investors and project developers to drive forward these solutions, given its independent and clear mandate on wave and tidal technologies and its links to academia, industry, and the financial community.

With regards to the first intervention mentioned in the above list, the ORE Catapult has a project currently underway to develop a stage-gated assessment process that will enable a clear evaluation to be made of the likelihood of a marine technology device achieving commercialisation. Having this underway is a first step in setting up some of the required structures for other interventions listed above including the future development of any enabling technologies resulting from intervention number 3, and assisting with the technology assessment required to unlock funding in a syndicated investment fund as outlined in intervention number 2.

We are currently working with key partners to explore interventions numbers 2 and 3 by outlining key stakeholders, determining industry interest, and designing the required investment structures and oversight required for their implementation.

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