CATAPULT
Offshore Renewable Energy

CROWN ESTATE SCOTLAND: MARKET ENGAGEMENT OF INDUSTRY ON CURRENT AND FUTURE LEASING OPPORTUNITIES FOR WAVE AND TIDAL ENERGY

Market Engagement – Executive Summary

Authors: Simon Cheeseman, Teo van der Kammen and David Findlay

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In partnership with:

Crown Estate Scotland
Oighreachd a' Chrùin Alba

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NOMENCLATURE

AR	Allocation Round
CES	Crown Estate Scotland
CfD	Contracts for Difference
FID	Final Investment Decision
kW	kilowatt
LCoE	Levelised Cost of Energy
MW	Megawatt
ODSL	Offshore Development Services Ltd
OEM	Original Equipment Manufacturer
ORE	Offshore Renewable Energy
PPA	Power Purchase Agreements
PPC	Protected Cell Company
SME	Small and Medium-sized Enterprise

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EXECUTIVE SUMMARY

This Executive Summary produced by Offshore Renewable Energy (ORE) Catapult summarises the work performed and findings from the wave and tidal energy market engagement survey undertaken in 2023.

Crown Estate Scotland commissioned ORE Catapult in July 2023 to conduct a formal survey and follow up one-to-one interviews with wave and tidal developers to gain an in-depth understanding of their deployment ambitions, project pipeline and market conditions. The aim was to gather feedback on the current leasing approach and understand where changes in the process may be beneficial to the wave and tidal sectors. The information gathered will be used by Crown Estate Scotland to inform a review of the leasing approach and future leasing activity.

A survey was issued in August 2023 to 29 organisations of which 26 replied, 10 wave and 16 tidal of which 3 were project developers. It asked recipients to declare their existing deployed capacity, their intentions to deploy in Scotland out to 2035, identify anticipated markets, describe projected minimum and maximum build out rate and timescale for projects, identify risks and limiting factors, describe ambitions for projects beyond 2035, identify supply chain challenges, innovation gaps and describe issues with the existing lease application process and how those would impact deployment plans. One-to-one interviews were conducted with a total of 21 respondents, 7 wave and 11 tidal and 3 project developers over a two-week period of 4 to 15 September 2023. ORE Catapult issued its full report of findings and recommendations to Crown Estate Scotland on 30 November 2023.

Report Findings

1.1 Markets

The analysis looked across both wave and tidal stream industries. Wave developers were focusing mostly on at sea applications (such as powering oceanographic equipment) or co-location with existing offshore infrastructure. The focus for wave developers was varied given the greater diversity of wave energy concepts and earlier stage of development. Off-grid applications where wave devices power offshore equipment, such as oil and gas platforms or oceanographic equipment, is an area of interest for wave developers (typically <100 kW [kilowatts]) as they can command significantly higher prices for developed power and often involve lower balance of plant costs compared to utility scale production.

Feedback showed that tidal energy developers were focusing on utility scale or community scale deployments. Utility scale devices, meaning devices of sufficient size to make an economically attractive investment when connected to the distribution or transmission network, was a common focus area for most tidal developers, with some already producing at utility scale. Remote communities and private wire high energy demand end users (e.g. refineries and energy islands) were also discussed as areas of interest for tidal developers. The key benefit with these markets is the ability to displace and decarbonise expensive electricity generation, which allows for a higher Levelised Cost of Energy (LCoE) removing dependence on revenue subsidy schemes. This is typically suitable for smaller scale technologies (<500 kW) in line with smaller scale electricity demands in remote communities. Community scale devices or arrays make an economic investment return when connected to a remote

community micro-grid or local network which will often have a higher marginal price or private wire or off-grid.

1.2 Sites

A common theme for most developers was the desire to enter or continue working in global markets. A wide range of countries and locations across the world were mentioned, with many being identified by multiple developers as desirable locations to deploy, see Figure 1 below.

As expected, available wave and tidal resource was a key driver for location selection. Another reason given was comparatively short timescales to secure consents, for example there was a perception that leasing routes in Canada were faster in comparison to the UK.

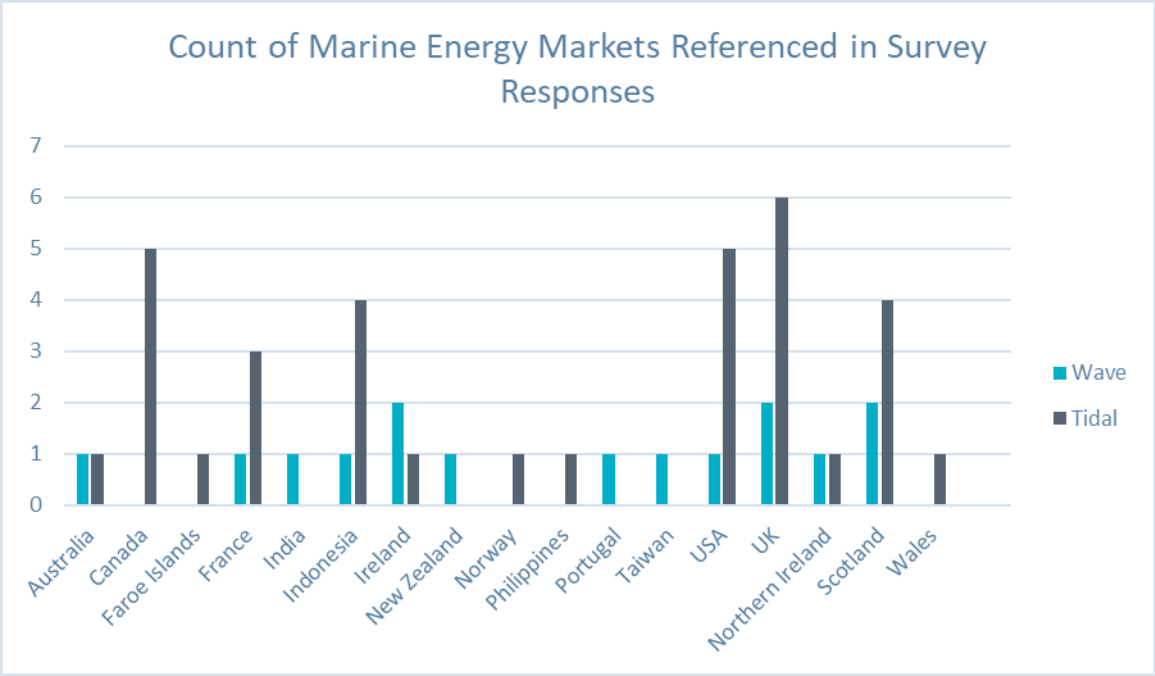

Figure 1. Bar chart of marine energy markets referenced during the survey.

1.3 Deployed Capacity

All the UK based deployed capacity mentioned in the survey responses and interviews was focused in the north of Scotland, with the majority being tidal energy. This will change over the next 2-4 years as in addition to Scottish projects by Magallanes, MeyGen, Nova Innovation and Orbital Marine Power, the Morlais tidal stream site comes online in Anglesey, Wales, with the first Contracts for Difference (CfD) Allocation Round (AR) 4 project in 2025/2026 and for AR5 projects deploying from 2026/2027.

1.4 Project Pipeline

The true project pipeline for wave and tidal developers was difficult to accurately establish. Many developers stated there was uncertainty in future leasing capacity, consenting, subsidy and investment.

Generally, 30 MW (megawatt) was regarded as the springboard to array scale commercialisation by the majority of tidal stream developers. This coincides with the existing 30 MW capacity ceiling for Crown Estate Scotland's existing ad-hoc leasing option.

With some exceptions, wave project plans tended to be smaller and less ambitious where most wave energy respondents considered themselves technology developers rather than project developers. This is despite a longer history of wave energy device development, and a significantly larger global resource potential.

1.5 Project Development Timelines

The survey took a close look at what factors were driving development timelines, see Figure 2 below which shows wave and tidal development phases with standard deviation in responses. Some of the stages are expected to happen in parallel rather than consecutively. For example, grid connection applications, site surveying and consenting can be initiated simultaneously.

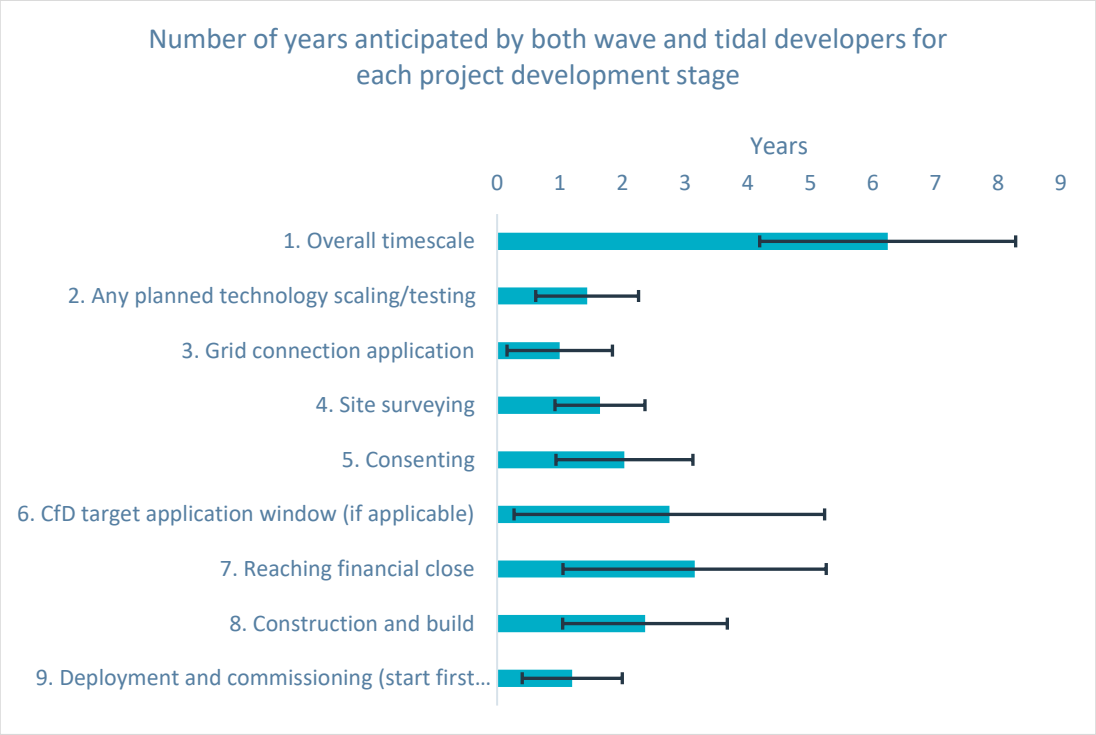

Figure 2. Survey respondents' estimate in years for the duration of project development phases for both wave and tidal energy projects. Error bars represent the standard deviation.

Limiting factors for tidal: There was consistency across developers in highlighting key risks that impact deployment timescales (Figure 3). The single greatest risk to progressing tidal stream project development identified by developers was the consenting process, without achieving consent a project cannot access the CfD revenue support and seek project Final Investment Decision (FID).

The second greatest perceived risk is access to grid connection, again without a grid connection offer the CfD revenue support cannot be accessed jeopardising project FID. Both risks are incurred early in

the project development stage, the cost for which is born by the project developer entirely at their own risk.

The third greatest risk was achieving financial close on a project. Without reaching FID a project developer will not recover its project development costs for that project. These are significant costs that typically could range from hundreds of thousands of pounds and depending on the extent of environmental survey data collection needs could approach one million pounds. For small and medium-sized enterprise (SME) developers being exposed to these costs, which may not be recoverable, often puts them in a difficult position.

Technology scaling and testing were cited minimally indicating that the industry has high confidence in its ability to develop and commercialise technologies.

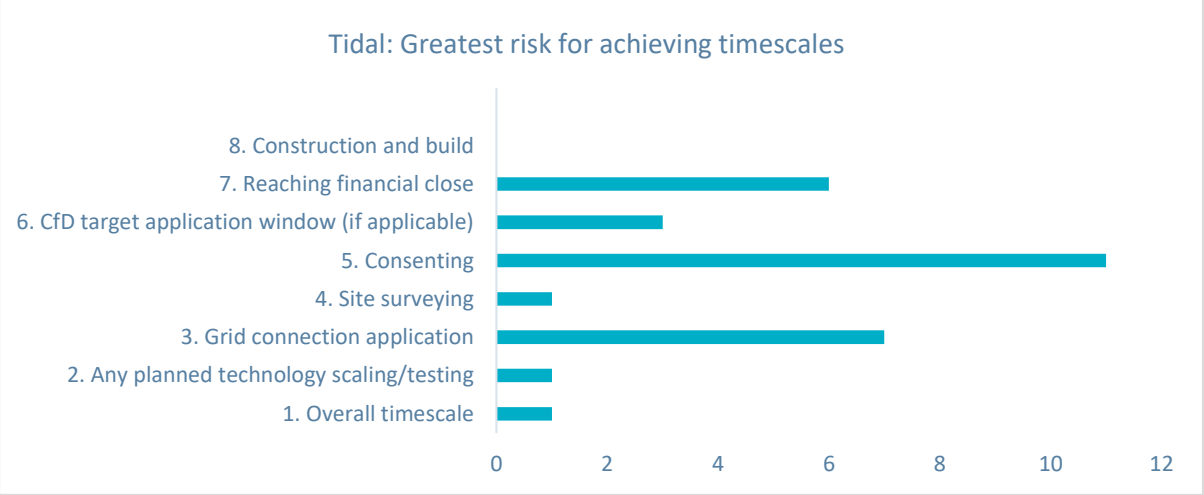

Figure 3. Greatest risk to tidal energy achieving timescales.

Limiting factors for wave: The most common risks identified by wave energy developers were consenting, reaching financial close and securing a grid connection. Technology development and scale up were seen as a bigger risk for wave developers than for tidal.

Most wave energy technology developers were keen to focus exclusively on technology development rather than become project developers as this involves a different set of risks, financial challenges and objectives.

A big issue for the sector is a lack of dedicated, technology agnostic, wave energy project developers, most likely due to the lack of design convergence and commercially attractive wave energy technology providers. An overall view of risks to wave development is shown below in Figure 4.

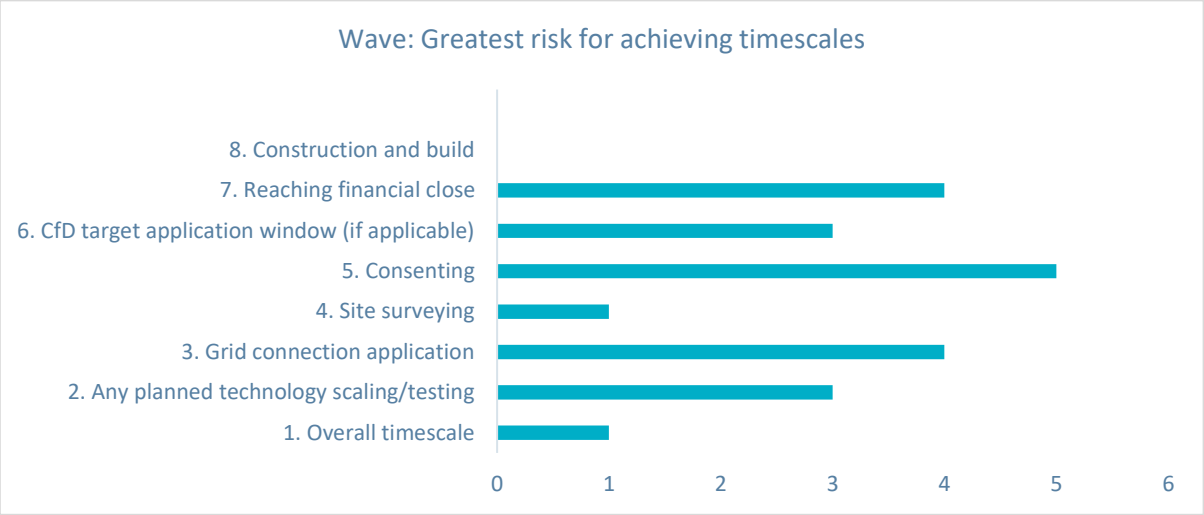

Figure 4. Greatest risk to wave energy achieving timescales.

1.6 Supply Chain

There were mixed feelings about supply chain readiness. Generally, developers with more established designs and systems in the water were more confident that the supply chain could transition to volume manufacture.

Several visualised a hub and spoke manufacturing model to serve multiple sites, but thinking had not established the ideal location for the hub other than wanting to benefit from local enterprise initiatives and logistics links to component manufacturers and deployment ports.

Some developers felt that the supply chain was unresponsive as the small volumes being procured by individual companies prevented any latitude for price negotiation. Major focus areas for supply chain development are shown in Figure 5 below.

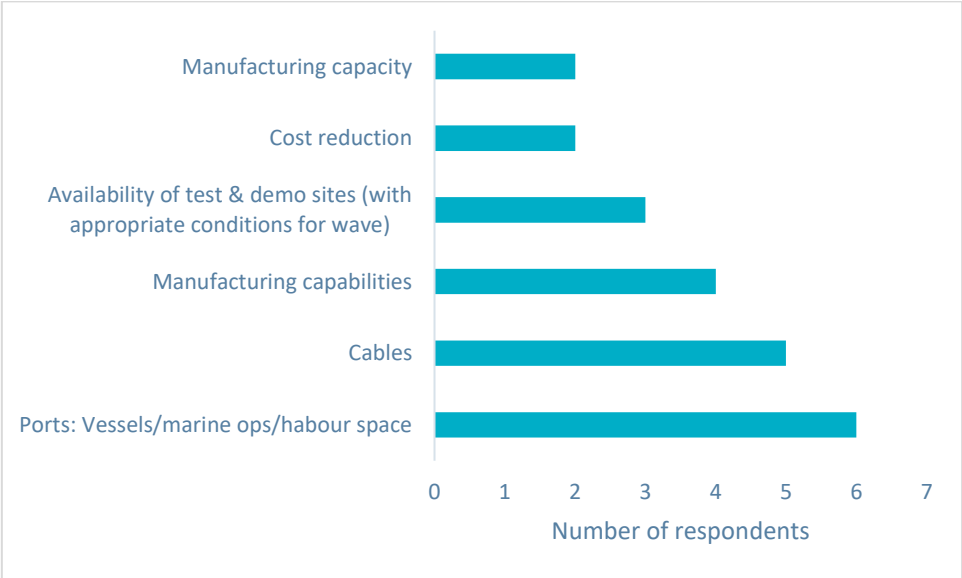

Figure 5. Development areas suggested for the supply chain.

1.7 Consenting

All developers with experience of the consenting process shared the concern about the time required and cost of consenting. This was driven by an inherent risk of cost overrun due to a lack of upfront definition of what data was needed to be collected to satisfy regulators. There was then a tendency for regulators to ask for additional data. Many new developers with less deployment experience had not considered the need for ongoing monitoring post deployment.

For **tidal developers** it was acknowledged that the industry is building a strong evidence case for environmental interactions with their projects and that better sharing and consideration of this available data may help accelerate the consenting timeline. This would require cross regulatory alignment and collaboration between particularly Scottish and Welsh jurisdictions as well as others from further afield.

Wave energy developers recognise the challenges and time constraints of achieving consents. Most respondents and interviewees identified as technology developers as opposed to project developers, and were therefore less directly concerned about these issues albeit cognisant of them. Onerous consenting hurdles can be particularly challenging for smaller, less well funded technology developers – particularly those developing smaller devices for off grid applications where the proportionality of a one size fits all consenting process may be questioned.

1.8 Grid

Developers planning potential new sites were increasingly concerned that they would be competing with solar and particularly a high volume of new offshore wind projects applying for grid connection and the escalating costs of cabling and delays resulting from required grid infrastructure upgrades. In addition, it was signalled that the renewables sector needs to collaborate on grid connection strategy and development of innovative wet mate connectors at 11 kV, inter array cables, and array architecture design to drive economies of scale and to provide conformity performance modelling.

According to developers there is a substantial grid capacity constraint in Scotland, therefore grid connections need to be upgraded to handle the increase in electrical output from commercial and test and demonstration sites. Regarding larger scale developments, for example array scale, electrical architecture requires solutions such as subsea hubs and robust topology setup, related to daisy chaining and inter-array connections. These upgrades need a clear decisive planning strategy at the outset to inform technology innovation to meet the next generation of technologies.

Grid reinforcement is also considered an aspect influencing the feasibility of where wave and tidal resource should be deployed. Grid connections need to be seen to be available at the right time to support the development and growth of commercial scale wave and tidal projects to enable their expansion in the wider energy system.

Co-location with offshore wind projects was an area of key interest for wave developers as the wave resource will align to some extent with the wind resource. The possibility of sharing the same grid connections could help improve grid connection capacity factor where wind farm operation capacity factor particularly for older arrays can be around 30%.

The feedback was that developers wanted further information and clarity on grid capacity linked to lease access and lease availability from Crown Estate Scotland in some guidance or roadmap to future upgrades potential.

1.9 Subsidy

All developers were concerned about uncertainty surrounding access to a long-term multiyear revenue subsidy required to reach financial close for their projects and attract longer term private investment into their companies. The current annual framework and allocation round budget announcement is far too reactive to enable longer term private investment in both wave and tidal stream. One response highlighted the success of CfD AR1 where tidal stream had a 100 MW minima which led to several original equipment manufacturer (OEM) entrants into the tidal market.

Smaller scale technologies are unable to benefit from economies of scale resulting in not being competitive enough to succeed in the CfD auction process, a revenue mechanism which awards technologies and projects with the lowest Levelised Cost of Energy. This results in small scale tidal stream (<500 kW) and wave energy technologies that are unable to access revenue support to help finance prototype demonstration projects. This is also the reason behind these technologies targeting Private Power Purchase Agreements (PPA) as this opens an alternative viable revenue stream.

It was recognised by various developers that the current CfD process gives no consideration to the overall benefit of the predictability of tidal stream on the wider electrical system. Technologies such as wave and tidal with higher LCoEs will have some beneficial impact for grid balancing that could reduce overall grid operating system costs. Wave and tidal developers would support a higher weighting on broader electrical system benefits in awarding sites, rather than just on LCoE.

1.10 Leasing

Across all developers there was agreement that the advantages of the existing leasing process needed to be more clearly advertised, the application process needed to be streamlined and cater for a growing requirement for larger capacity sites over and above 30 MW.

For **tidal developers** the consensus was that larger seabed leases are required to help build the required future project portfolios needed by industry to attract private investors. In some cases, developers pushed for the capacity limit to be removed completely and to bring back a competitive leasing process. CfD budget availability would likely become the natural limiting factor for these projects. One developer did however see an advantage to maintaining smaller c.30MW leases but enabling more of them to spread project development risk.

Smaller scale tidal developers (<500 kW) are targeting rural or island community areas which are not grid connected and are reliant on relatively more expensive electricity this is due to their inability to compete in the CfD process at that scale. These locations could be easily identified and perhaps a fast-track seabed leasing process for these smaller community-based projects could be developed.

Developers noted that careful consideration and management will be needed in relation to the risk of neighbouring site interactions and to allow for the growth and expansion of newly consented sites in future perhaps using exclusivity areas around the lease areas. One developer suggested using an expanded Section 36 and grid connection application processes to allow a time limited option for subsequent site expansion. It was proposed that developers could apply for a much expanded Section

36 licence which incorporates their project and a further expansion option area connected to it. The developer proposed that Crown Estate Scotland could, in conjunction with awarding a lease for the immediate project, also award a time limited, data driven and milestone-based option for expanding the site in line with the wider Section 36 award. A suggested milestone was the CfD award requirement of 18-month 10% project budget spend which when achieved could trigger the expansion option by Crown Estate Scotland.

Some developers believed the cap of 4 Option Agreements at any one time set by Crown Estate Scotland is limiting their ability to build up sufficient future project portfolio and driving some to seek projects overseas to add to their portfolio instead. The cap on the number of Option Agreements should be reviewed ensuring the seabed is protected from land banking by market prospectors. Developers suggested this could be done based on applicants' track record of historic successful project development (projects built and operating), or through competitive leasing opportunities – where competition would award serious developers rather than potential land bankers.

In general, **wave developers** had no demand for a new, bespoke leasing process for utility scale wave energy above 30 MW in the immediate future, although this requirement should be kept under review as the sector develops. Feedback was that a flexible and adaptable approach to leasing is preferred, requests for site leases should be assessed on a case-by-case basis and Crown Estate Scotland should maintain the current ad hoc open policy for new applications.

Several **wave energy developers** targeting on-site generation (e.g., for oil and gas or aquaculture) felt that the wave energy aspect should be considered ancillary to the broader site use and not require a separate lease for the wave energy component. Examples where this may be the case include:

- the case where a floating wave energy device is used to provide power and communications to a seabed oil and gas installation;
- an aquaculture farm where a wave energy device is located within the lease area of the aquaculture farm and the power is consumed directly by the farm;
- an aquaculture farm where the wave energy device is incorporated into the feed barge structure or mooring system and power is consumed by the feed barge;
- a moored metocean measurement buoy or floating lidar system which incorporates an onboard inertial reference wave converter for power sensors and communications systems;
- an unmoored, station keeping survey vessel that uses wave energy to provide power for onboard systems.

Clarifying the circumstances where wave energy could be considered ancillary equipment would be helpful to both technology developers and end users.

1.11 Investment & Funding

There was general agreement that the current CfD ringfence is insufficient to support projects up to the current 30MW seabed lease maximum. The lack of long-term certainty around available ringfenced budget for tidal stream is a particular barrier for longer term private investment and the wider CfD mechanism is not fit for the nascent wave industry which would be required to compete for budget with tidal stream and floating offshore wind.

For **tidal energy developers** longer term visibility of Government policy support for tidal stream through the CfD mechanism is required. Currently the annual budget announcement for the following

Allocation Round is too short term and reactive to provide investors with long term certainty around route to market. The annual cycle of CfD allocation rounds is at risk of outpacing the tidal stream industry project development pipeline.

Securing investment is challenging for **wave energy developers** given previous high-profile failures and a high level of perceived risk in general. Early demonstration projects are typically funded through public funding, private/high net worth investment, or crowd source funding. Large private equity funds typically hold a negative view of the sector and only the most credible and developed companies can raise the significant funding required to take forward a serious large scale development program.

1.12 Insurance

Developers recognised and were concerned about the difficulties in finding commercial insurance products. Some developers had worked hard to secure bespoke cover for some elements of their project but admitted the situation was far from ideal and was a contributing factor to the high cost of capital and Securing insurance affecting the 'investibility' of a project.

The lack of creditworthiness of either project developer companies or (typically) technology providers also creates closely related problems in respect of the need to provide decommissioning securities and parts, labour, and availability warranties (including marine operations costs).

Developers showed a lot of interest in the proposed interim insurance model based on a Protected Cell Company (PCC) captive insurer. This new insurance model has been discussed extensively with industry and ORE Catapult is looking for funding support to implement a pilot project working with Department for Energy Security and Net Zero.

1.13 Conclusions

Overall, it was found there was a positive appetite from technology developers to accelerate both wave and tidal deployment in Scotland. Developers need to be prepared to provide clearer details of their scale up ambitions to support the Crown Estate Scotland planning process. There was broad consensus on the challenges and the opportunities to enhance the leasing process to enable commercial development and the need to provide reassurance on access to grid and provide greater certainty in the consenting process .

Developers welcomed the survey as an opportunity to provide feedback and many felt that a common forum to enable discussion and provide visibility on these issues would be beneficial.

1.14 Recommendations

1.14.1 Now is an appropriate time to provide a clear distinction between the wave energy and tidal stream sectors because of tidal stream's advanced technology maturity and deployed capacity and readiness for commercialisation.

1.14.2 We would suggest that the wave and tidal technology and site developers would appreciate an opportunity to have regular round table engagements with Crown Estate Scotland to be briefed on the latest thinking and provide feedback.

1.14.3 The existing leasing process should be more clearly advertised, the application process itself could be adapted to cater for a growing requirement for larger capacity sites over and above 30MW.

1.14.4 Look at ways to support and accelerate the introduction of cross sector initiatives such as tailored commercial insurance services, alternative bond mechanisms, minimising uncertainty in the consenting process, sharing environmental impact learnings between different jurisdictions, and supply chain cluster development pulling in lessons from other marine sectors.

CATAPULT
Offshore Renewable Energy

GLASGOW

ORE Catapult
Inovo
121 George Street
Glasgow
G1 1RD

+44 (0)333 004 1400

BLYTH

National Renewable
Energy Centre
Offshore House
Albert Street, Blyth
Northumberland
NE24 1LZ

+44 (0)1670 359555

LEVENMOUTH

Fife Renewables Innovation
Centre (FRIC)
Ajax Way
Leven
KY8 3RS

+44 (0)1670 357649

GRIMSBY

O&M Centre of Excellence
ORE Catapult, Port Office
Cleethorpe Road
Grimsby
DN31 3LL

+44 (0)333 004 1400

ABERDEEN

Subsea UK
30 Abercrombie Court
Prospect Road, Westhill
Aberdeenshire
AB32 6FE

07436 389067

CORNWALL

Hayle Marine Renewables
Business Park
North Quay
Hayle, Cornwall
TR27 4DD

+44 (0)1872 322 119

PEMBROKESHIRE

Marine Energy Engineering
Centre of Excellence (MEECE)
Bridge Innovation Centre
Pembrokeshire Science
& Technology Park
Pembroke Dock, Wales
SA72 6UN

+44 (0)333 004 1400

CHINA

11th Floor
Lan Se Zhi Gu No. 15
Ke Ji Avenue,
Hi-Tech Zone
Yantai City
Shandong Province
China

+44 (0)333 004 1400

LOWESTOFT

OrbisEnergy
Wilde Street
Lowestoft
Suffolk
NR32 1XH

01502 563368