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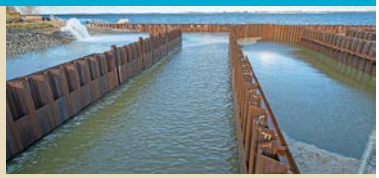
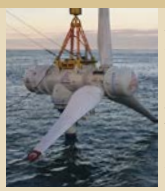
GLOBAL MARINE SPECIAL REPORT 2018

Tidal turning point





Atlantis AR1500 turbine due to be redeployed by the year-end at the MeyGen Phase 1A tidal array Photo: Simec Atlantis

Tidal swells towards commercial lift-off

Deployment could soar over next three years while wave device developers work to build trust in their technologies, writes **Tim Probert**

The global marine energy sector is making slow but steady progress as clear signs emerge of market convergence in a tidal industry gearing up for commercial roll-out in the next decade.

Figures compiled by reNEWS *(see page 3)* indicate global installations will hit just under 15MW next year, roughly double the 7MW deployed in 2018.

The tidal sector is expected to get into its stride from 2020 with 40MW scheduled to go into the water that year, rising to 215MW in 2021 led by Simec Atlantis Energy's efforts off northern France.

The UK stock-listed company has set out a clear strategy to form close partnerships with French and European Union policymakers to fulfil its highly ambitious plans to deploy 1GW in the English Channel by the mid-2020s.

The first step was the creation last month of its Normandie Hydrolienne joint venture with the regional Normandy government, which aims to install a 200MW array in the Raz Blanchard by the end of 2021.

The next stage is to tap European Union institutions such as the European Investment Bank for financial support to enable construction of its proposed projects, using equipment made in Normandy.

If Atlantis pulls off its plan the company will have taken a major leap towards true mass-production of its flagship AR2000 2MW subsea turbine.

The company has invested more than £5m in the development of a horizontal axis AR2000 machine, a pair of which are due to be installed next year at its MeyGen Phase 1A pilot array in the Pentland Firth off northern Scotland.

Following the demise of OpenHydro in the summer, when French parent Naval Energies pulled the plug citing unworkably high costs, the prospects for non-traditional horizontal tidal turbines appear less bright.

The company disappointed many in the tidal industry with its valedictory statements that the technology would never be able to compete with other renewable sources of generation such as wind and solar.

If the battle between seabed turbines has arguably already been won by three-bladed horizontal axis machines, floating tidal is putting up a good fight. Recently rebranded Scottish developer Orbital Marine Power is in bullish mood after posting impressive performance figures from its SR1-2000 2MW unit deployed at the European Marine Energy Centre off Orkney. The developer will kick off fabrication of its next-generation Orbital O2 next year for installation in 2020 at EMEC.

Canada is trying to recover lost ground following the demise of joint venture Cape Sharp Tidal by backing DP Energy's Uisce Tapa project at the Fundy Ocean Reseach Centre for Energy test site in Nova Scotia.

The up to 9MW project featuring Andritz Hydro machines is a result of the Canadian province stepping up its ambition to harness its abundant tidal energy resources in the Bay of Fundy.

Black Rock Tidal Power, Big Moon Power and New Energy Corporation are among the developers set to kick off projects in the world's largest tidal range over the coming years.

Two of the Nova Scotia projects scheduled by 2020 will feature tidal technology designed in Scotland, which is not only testament to the depth of knowledge in that nation but also a sign that some developers are looking abroad due to a lack of targeted UK regulatory support.

The Scottish and Welsh regional governments continue to bang the drum for 'innovation power purchase agreements', which would give tax breaks to offtakers and Westminster has recognised the possibility such supports may be needed.

Tidal development elsewhere tends to focus on Western companies trying to find new markets for their technology but lack of regulatory support appears to be hampering progress, particularly in south-east Asia.

Wave technology, meanwhile, is being led by Scandinavian developers. Swedish outfit Corpower is taking a measured approach to ensure its point absorber kit is tested and trusted rather than over-promising and under-delivering.

Finnish wave developer AW-Energy, which is due to install its first commercial WaveRoller device next year in Portugal following a lengthy development phase, is pursuing a similar strategy. ■

GLOBAL DEPLOYMENT PATHWAY

Developer	Location	kW	Technology	Type
Installed or due in 2018				
40South Energy	Pisa, Italy	25	H24	Wave
Aqua Power Technologies	Clift Sound, Shetland, UK	5.2	Manta	Wave
Big Moon Power	Minas Passage, Nova Scotia, Canada	100	Kinetic Keel	Tidal
Black Rock Tidal Power	Grand Passage, Nova Scotia, Canada	280	PLAT-I	Tidal
Cape Sharp Tidal	FORCE Berth D, Canada	2000	OpenHydro	Tidal
CorPower	EMEC, Scotland, UK	25	S3	Wave
Crestwing	Kattegat, Denmark	300	Tordenskiold	Wave
DesignPro	Seeneoh, France	25	GKinetic	Tidal
Fred Olsen	WETS, Hawaii, USA	30	Bolt Lifesaver	Wave
Geps Techno	Sem-Rev, France	150	IHES	Wave
Guinard Energies	Amboarakely, Madagascar	4	P66	Tidal
Guinard Energies	Arzon, France	3.5	P66	Tidal
Hydro Air Concept Energy	Port of La Rochelle, France	50	HACE	Wave
HydroQuest	Caluire et Cuire, France	320	HydroQuest River	Tidal
Magallanes Renovables	EMEC, Scotland, UK	2000	Atir	Tidal
Marine Power Systems	Milford Haven, Wales, UK	10	WaveSub	Wave
Minesto	Holyhead Deep, Wales, UK	500	DG500	Tidal
NeptuneWave	Strait of Georgia, British Columbia, Canada	25	Neptune	Wave
New Energy Corporation	Portsmouth, New Hampshire, USA	25	EnviroGen	Tidal
Okinawa Institute of Science and Technology Graduate University	Kandooma Island, Maldives	16	OIST WEC	Wave
Sabella	Ushant, France	1000	D10	Tidal
SINN Power	Heraklion, Crete, Greece	48	SINN Power	Wave
Tecnalia	Bimep, Spain	30	Marmok-A5	Wave
TOTAL				**6.97MW**
Coming in 2019				
AW-Energy	Peniche, Portugal	350	WaveRoller	Wave
Big Moon Power	Minas Passage, Nova Scotia, Canada	1000	Kinetic Keel	Tidal
Black Rock Tidal Power	Grand Passage, Nova Scotia, Canada	420	PLAT-I	Tidal
Blue Shark Power	Bab-el-Mandeb, Djibouti	240	Blue Shark	Tidal
Blue Shark Power, LHD	Zhoushan, Zhejiang, China	300	Blue Shark	Tidal
China Shipbuilding Industry Corporation	Zhoushan, Zhejiang, China	450	SG500	Tidal
Columbia Power Technologies	WETS, Hawaii, USA	500	Stingray	Wave
Deepwater Energy	TTC-Grevelingendam, Netherlands	1000	Oryon Watermill	Tidal
Enel Green Power	Valdivia, Chile	3	OPT PowerBuoy PB3	Wave
Guinard Energies	French Guinea/Madagascar tbc	150	P154	Tidal
Guinard Energies	Ria d'Etel, France	20	P400	Tidal
Hydro Air Concept Energy	Blanquefort, France	200	HACE	Wave
HydroQuest	Genissiat, France	2040	HydroQuest River	Tidal
HydroQuest	Paimpol-Brehat, France	1000	HydroQuest Ocean	Tidal
Instream Energy Systems	EMEC, Scotland, UK	100	Instream	Tidal
Laminaria	EMEC Billia Croo, Scotland, UK	200	Laminaria	Wave
Minesto	Keelung, Taiwan	100	DG100	Tidal
Nemos	Ostend, Belgium	5	Nemos	Wave
New Energy Corporation	Bay of Fundy, Nova Scotia, Canada	50	EnviroGen	Tidal
Nova Innovation	Shetland, Scotland, UK	100	M100	Tidal
Ocean Energy	WETS, Hawaii, USA	500	OEBuoy	Wave
Pentair Fairbanks Nijhuis	TTC-Grevelingendam, Netherlands	1000	Bi-Directional Turbine	Tidal
Simec Atlantis Energy	Pentland Firth, Scotland, UK	3400	AR2000	Tidal
Sinn Power	Heraklion, Crete, Greece	72	SINN Power	Wave
Tocardo	EMEC, Scotland, UK	1350	UFS	Tidal
Verdant	Roosevelt Island, USA	105	KHPS Gen5	Tidal
Waves4Power	Runde, Norway	250	Next Generation	Wave
Wave Swell Energy	King Island, Tasmania, Australia	200	WSE	Wave
Wello	EMEC, Scotland, UK	1000	Penguin WEC-2	Wave
Wello	EMEC, Scotland, UK	1000	Penguin WEC-3	Wave
TOTAL				**14.8MW**
Scheduled for 2020				
Black Rock Tidal Power	FORCE Berth B, Canada	1680	PLAT-1	Tidal
Blue Shark Power	Bab-el-Mandeb, Djibouti	18960	Blue Shark	Tidal
Bombora Wave Power	META, Wales, UK	1500	mWave	Wave
Carnegie Clean Energy	Albany, Australia	1500	Ceto 6	Wave
DP Energy	FORCE Berth E, Canada	7500	Andritz Hydro Mk1	Tidal
Orbital Marine Power	EMEC, Scotland, UK	2000	Orbital O2 2MW	Tidal
ORPC	Cobscook Bay, Maine, USA	300	TidGen	Tidal
Minesto	Vestmannasund Strait, Faroe Islands	200	DG100	Tidal
New Energy Corporation	Bay of Fundy, Nova Scotia, Canada	250	EnviroGen	Tidal
Nova Innovation	Bardsey Sound, Wales, UK	1000	M100	Tidal
Nova Innovation	Shetland, Scotland, UK	100	M100	Tidal
Tidal Sails	Hammerfest, Norway	4400	TackReach	Tidal
Wavepiston	Hanstholm, Denmark	350	Wavepiston	Wave
TOTAL				**39.68MW**
Slated for 2021				
Marine Power Systems	Wave Hub, Cornwall, UK	1500	WaveSub	Wave
New Energy Corporation	Bay of Fundy, Nova Scotia, Canada	1250	EnviroGen	Tidal
Nova Innovation	Shetland, Scotland, UK	100	Nova M100	Tidal
SBS Energi Kelautan	Lombok island, Indonesia	12,000	Atlantis AR	Tidal
Simec Atlantis Energy	Raz Blanchard, Normandy, France	200,000	Atlantis AR2000	Tidal
TOTAL				**214.85MW**
Pencilled for 2022				
Sabella	Ushant, Brittany, France	2000	D12-1000	Tidal
TOTAL				**2.0MW**
Set for 2023				
Big Moon Power	Minas Passage, Nova Scotia, Canada	4000	Kinetic Keel	Tidal
TOTAL				**4.0MW**
GRAND TOTAL				**282.28MW**

Atlantis counts pennies for MeyGen 1C CfD bid

Progress for company's French tidal projects key to lowball calculation in UK contract auction

Simec Atlantis Energy is poised to take Scottish tidal to the next level as the company goes all out to secure price support in next year's Contracts for Difference auction for an 80MW-plus MeyGen 1C project in the Pentland Firth.

The developer is eyeing a bid of between £60 and £80 per megawatt-hour for a MeyGen extension in the allocation round due to kick off by May, it is understood.

Sources said Atlantis wants to make full use of its full 86MW consent window at MeyGen, which includes the operational 6MW Phase 1A, but also wants to increase the scope of the site off Caithness. "We are submitting applications to increase the consent," said one. "We will bid at least 80MW but ideally it would be closer to 200MW."

CfD rules dictate all projects seeking price support need full consent when the auction kicks off. "We are not confident it will get through by first quarter 2019," the source added.

If Atlantis is successful in securing a contract for MeyGen 1C the project, consisting of at least 40 of its own AR2000 2MW turbines, would be installed from 2023. The lowball CfD bid is said to be contingent on Atlantis progressing its French projects, which include a 20MW pilot by 2021 and 200MW array by 2024 in the Raz Blanchard off Normandy.

In the long run, Atlantis is targeting a levelised cost of €66/MWh, below today's UK baseload price of around £68/MWh. "We need to get a position to produce 250 turbines. That is the magic number," the source said. There is a "strong possibility" the MeyGen turbines would be made in Normandy.

Atlantis is meanwhile planning to deploy two of its new AR2000 turbines at MeyGen Phase 1A by the end of 2019. The next-generation hardware features rotor diameters of up to 24 metres, an increase of six metres from on the AR1500 rotors.

The machines will be de-rated to 1.7MW and the existing Atlantis 1.5MW AR1500 turbine will be uprated to the same capacity. The three Andritz Hydro Mk1 1.5MW turbines at the site will each be downrated to 300kW so that the total Phase 1A capacity will remain unchanged at 6MW.

However, Atlantis expects the yield from the site to increase by 40%. The company will also deploy a new subsea connection hub, which will allow the new turbines to use a single connection cable.

The gravity-based foundations for the two

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04 AR2000 machines will be supplied by either Nigg-based Global Energy Group or Fife yard BiFab. Hardware will be deployed by the Atlantis Operations subsidiary, but vessels have yet to be sourced.

Atlantis is meanwhile stepping up ambitions in the tidal race between Alderney and the Cap de la Hague on the Cherbourg peninsula, which has one of the strongest tidal flows in the world. In addition to its 2GW plans in French waters, Atlantis has a long-term target of 1GW of tidal development in areas under the jurisdiction of the States of Alderney.

"We will potentially enter into negotiation with States of Alderney where we would give them a royalty," the source said. "What we want are those 42 blocks of possibly the best tidal resource in the world outside the Bay of Fundy."

Alderney Commission for Renewable Energy last year cancelled a 65-year permit with Alderney Renewable Energy for the development of tidal around the Channel island. ARE signed an agreement with defunct Irish tidal turbine fabricator OpenHydro in 2014 for a 300MW array in Alderney waters.

Atlantis is aiming to redeploy two turbines at its MeyGen 1A during the December tidal window following maintenance. The single Atlantis AR1500 machine and third Andritz Mk1 unit will be returned to service after completion of works at the Atlantis operations base at Nigg Energy Park in Easter Ross.

QUICK TURNAROUND: Andritz Hydro Mk1 turbine being prepped at Nigg Energy Park in Easter Ross ahead of redeployment at Atlantis' MeyGen 1A tidal array in the Pentland Firth Photo: Simec Atlantis Energy

The Agence de Développement pour la Normandie-led Marine Energy Integration with Smart Distribution and Storage (Midas) project, backed by €11m of EU Interreg North West Europe programme funding has been discontinued.

The project would have featured an Atlantis device, deployed at the developer's Fall of Warness berth at the European Energy Marine Centre, Orkney.

A 600kW/3MWh flow battery supplied by RedT Energy was to have been integrated into the scheme. ■

Brexit worries tugging tidal developers away from UK

Sector leaders warn loss of support could jeopardise country's world-leader status as lobbying continues

Tidal developers are increasingly concerned about a lack of UK political support for the sector as the country braces itself for Brexit from March 2019.

The industry is facing a double whammy of a Conservative government said to be indifferent to marine and financial support mechanisms from European Union institutions being unavailable after withdrawal.

"We have seen long and consistent support from the European Commission and there is nothing good about Brexit from a sector point of view," said DP Energy chief executive and Ocean Energy Europe president Simon De Pietro.

The sector has lobbied UK induustry and energy department BEIS to support so-called innovation power purchase agreement (IPPA) proposals, which would give tax rebates to off-takers of pre-commercial marine projects of up to 5MW. Lobbyists had been hopeful of Treasury backing for plans to pay the difference between the wholesale power price and an administrative strike price set by government in the October budget.

ORKNEY BOUND: Magallanes Renovables' 2MW ATIR floating tidal device tow testing prior to deployment at EMEC

Photo: Magallanes Renovables

Nothing materialised, however, and sources said more work needs to be done to convince officials of the value for money from the IPPA proposition.

The industry was encouraged, however, by a letter sent to marine players last month by Energy Minister Claire Perry suggesting BEIS has opened the door to a new route to market.

The Welsh government and Scottish politicians have thrown their weight behind the IPPA proposals, sensing the opportunity to create high-value jobs in what are often remote communities.

The Marine Energy Council, established earlier this year, is also calling for a bridging mechanism for 10MW to 100MW projects, dubbed the iCfD. MEC chairwoman Sue Barr said the trade body will draw up a marine energy roadmap for UK waters as part of its work to "present the best possible evidence to government on the benefits of building on the UK lead."

De Pietro is unsure, however, whether Prime Minister Theresa May's administration is wholly convinced of the benefits of wave and tidal power.

"My view of the UK is that they think the job is done on renewables with offshore wind so they do not need to worry too much about anything else."

Lobbying of the UK government has been made more difficult by Brexit distractions, added De Pietro. "I do not think there is a lot of time and value in lobbying the Conservative government. It would be better, to be blunt, if there was a change of government."

Simec Atlantis Energy chief executive Tim Cornelius said the UK would likely lose its position of pre-eminence in marine if it chooses to follow its current regulatory path.

"There is a very real and present situation in the UK," he added. "Something like £450m has been spent by various forms of the public sector on developing the UK marine industry and it is absolutely without doubt a world leader, but it has every opportunity to potentially lose that."

Atlantis is eyeing Contracts for Difference support for its 80MW-plus MeyGen Phase 1C project but it is the only developer in a realistic position to bid in next year's auction. Other proponents have already switched focus to countries still offering a route to market.

Scotland-based Sustainable Marine Energy chief executive Jason Hayman said: "There is no home market at the moment so our project focus is in Canada."

The developer feels it had the carpet pulled from under its feet through the removal of targeted price support for tidal before it was commercially ready.

"You are not commercially ready until you can access project finance with substantial levels of debt," said Hayman. "That takes performance guarantees, availability guarantees and fixed-price O&M costs as offered by the wind industry."

Canada now offers a better policy line-of-sight for developers to prove tidal technology can compete with other forms of renewables generation, he believes.

"Nova Scotia is currently the only market in the world offering revenue support to get enough time in the water required to get through the valley of death." ■

Floating tidal heading into low-cost era

Orbital Marine Power is betting on its next-generation floating tidal technology to achieve a low-cost breakthrough for the sector when it is installed at the European Marine Energy Centre off Orkney in 2020. The company formerly known as Scotrenewables rebranded to Orbital in October in honour of the moon's gravitational effect on tides.

The Scottish developer said its Orbital O2 2MW machine will feature refinements to "vastly reduce" costs and help it move towards volume manufacturing.

Fabrication of the device at the Harland & Wolff shipyard is due to be completed by the end of 2019 ahead of deployment the following year at the Fall of Warness grid-connected site at EMEC. The floating machine will consist of a 73 metre-length steel hull, with key improvements including an increase in twin-rotor diameter from 16 metres to 20 metres.

The Orbital O2 will also feature a so-called 'gull wing leg actuation system' to improve access to the nacelles, and a new 360-degree blade pitching system, co-developed with Swedish engineers SKF.

Orbital chief executive Andrew Scott said the increased rotor size and pitch system would help it achieve a hoped-for increase in yield of 50% on the previous SR1-2000 device. "The pitch system will remove the requirement for the turbine to yaw, which means it will be moored far more simply fore and aft," he added.

The device will be installed for a minimum of 15 years as part of the Flotec project backed by a €10m EU Horizon 2020 grant. Orbital will also take advantage of its Ofgem accreditation for its Fall of Warness tidal berth at EMEC, worth five Renewables Obligation certificates per megawatt-hour.

Scott is bullish about the company's chances to take floating tidal to commercial reality following impressive results from the SR1-2000 at EMEC.

"We have learned a huge amount, also things we did not get right, so we understand where the challenges are to embark on a truly low-cost, low-risk solution." The device achieved a capacity factor in excess of 50% during a single tidal cycle, 40% over a week, and 20% over a year, net of inspection and maintenance interventions.

Orbital believes the relatively low cost of floating tidal installation and O&M is its ace card. "Turbine installation work was done with just a multicat vessel and rates never exceeded £3500 to £4500 per day."

Interventions were achieved in around 30 minutes from quayside with low-cost rib-style vessels, including in two-metre wave heights. "We can have continuous maintenance and access throughout the year quickly and cheaply," said Scott.

Orbital retrieved the SR1-2000 device in September and it is now sited at Inganess Bay, close to the company's base in Kirkwall on the Orkney mainland. The oufit is keen to find a second home for the machine and negotiations are continuing with a number of marine players on that score.

Spanish developer Magallanes Renovables, meanwhile, is due to install its 2MW Atir floating tidal platform at the Fall of Warness test site by the year-end.

Deployment of the 45-metre device with twin 19-metre rotors, which arrived in Orkney from the Spanish port of Vigo in September, is being overseen by local contractor Leask Marine.

Elsewhere in Scotland, Nova Innovation is ramping up activity for the installation of the first of three M100 tidal turbines that comprise its EU-backed EnFAIT project off Shetland. The Edinburgh outfit is aiming to deploy the 100kW machine in the Bluemull Sound by the end of 2019.

The €20m EnFAIT scheme consists of a three-turbine extension to its existing 300kW Shetland Tidal Array, due to be completed by June 2022.

In October, the tidal player commissioned a Tesla Powerpack battery integrated with the Shetland array to demonstrate a so-called 'plug and play dispatchable tidal solution'.

Other tidal developers due to be deployed in Scottish waters next year include Dutch outfit Tocardo, which plans to install its next-generation Universal Foundation System at an EMEC berth.

The company has wrapped up the design of the 1.35MW semi-submersible platform, consisting of five T2 turbines, and is working on the mooring systems ahead of deployment at the Fall of Warness.

Canadian tidal developer Instream Energy Systems, meanwhile, is negotiating with EMEC about a full-scale floating demonstration project of its 100kW, twin-rotor floating machine next year. ■

TIDAL ROLL CALL – SCOTLAND

Developer	Location	MW	Technology	Type
Installed in 2018				
Magallanes Renovables	EMEC Fall of Warness, Orkney	2	Atir	Tidal
TOTAL				**2.0MW**
Scheduled for 2019				
Instream Energy Systems	EMEC Fall of Warness, Orkney	0.1	Instream	Tidal
Nova Innovation	Bluemull Sound, Shetland	0.1	M100	Tidal
Simec Atlantis Energy	Pentland Firth	3.4	AR2000	Tidal
Tocardo	EMEC Fall of Warness, Orkney	1.33	UFS	Tidal
TOTAL				**4.95MW**
Coming in 2020				
Nova Innovation	Bluemull Sound, Shetland	0.1	M100	Tidal
Orbital Marine Power	EMEC Fall of Warness, Orkney	2.0	Orbital O2	Tidal
TOTAL				**2.1MW**
Slated for 2021				
Nova Innovation	Bluemull Sound, Shetland	0.1	M100	Tidal
TOTAL				**0.1MW**
CUMULATIVE TOTAL				**9.15MW**

LOOKING FOR A NEW HOME: The Orbital SR1-2000 2MW turbine recovered in the autumn from the European Marine Energy Centre's Fall of Warness tidal test site off Orkney Photo: Orbital Marine Power

WES duo carries wave hopes

Wave Energy Scotland is entering the home straight of a five-year programme to support the technology development of devices to be tested off Orkney in 2020. The Highlands and Islands Enterprise subsidiary will select the two wave generators to be installed at the European Marine Energy Centre within weeks.

Four developers are in the mix to deploy half-scale wave devices at the Scapa Flow or Billia Croo test sites: 4c Engineering, AWS Ocean Energy, Mocean Energy and Checkmate Seaenergy.

WES chief executive Tim Hurst believes the two first-of-a-kind, proof of concept demonstrations will give the Scottish wave industry a much-needed boost. "We need to get some proven technology and we have not got that yet, but we will have selected the best from a five-year programme and done all the engineering derisking.

"Hopefully we can point to the demos as showing wave power is reliable, with the right performance and cost model, and move forward from there," he added.

WES is also due to select which developer or developers will progress to a possible fourth and final stage of its power take-off call. Stage three work is underway by four projects: The University of Edinburgh's C-GEN, Artemis Intelligent Power's Quantor, Ecosse Subsea Systems' Power Electronic Controlled Magnet Gear and Umbra's Electro-Mechanical Reciprocating Generator.

Earlier this year Swedish developer Corpower wrapped up testing of its HiDrive PTO as part of its C3 half-scale device deployment at Scapa Flow, the first WES-funded device to be trialled at sea. WES is funded up to the next Scottish parliamentary election, due to take place by May 2021. The public sector body has so far invested £30.9m in 84 projects involving 177 organisations from 13 countries, and published over 100 documents.

Hurst said he has had no talks with Holyrood over the future of WES beyond 2021 but it aims to play a key role in an EU-wide pre-commercial wave procurement initiative to be funded via the Horizon 2020 R&D programme. The Inverness-based official is also banking on the UK participating in Horizon Europe, the successor to Horizon 2020.

Elsewhere in Scottish wave, Finnish developer Wello is preparing to deploy the second of three 1MW Penguin devices at Billia Croo from February. Chief executive Heikki Paakkinen said fabrication of the wave machine at the Netaman shipyard in the Estonian capital, Tallinn, has been delayed.

"Installation should be from February to March after towing from Estonia to Scotland, depending on weather-windows at that time of the year. There is some risk for ice on Northern Baltic Sea that time of the year," he added. Paakkinen said the Espoo outfit is still on track to deploy the third Penguin by the end of 2019 as part of its Clean Energy from Ocean Waves project, backed by a €17m EU grant.

Installation of the devices will be overseen by local vessel operator Green Marine.

Belgian wave outfit Laminaria has meanwhile hit fabrication snags with its 200kW device, due to go in at Billia Croo early next year.

The main structure of the surge and pitch-operated point absorber has been completed at a Zeebrugge yard but fit-out has yet to be finished. Laminaria received a permit from Marine Scotland in July to install the device at EMEC's grid-connected wave test site until the end of 2019.

English developer Aqua Power Technologies installed its 5.2kW Manta semi-submersible wave device in July at Scottish Sea Farms' Teisti Geo fish farm off Shetland. The Cumbrian company can test the point absorber until May 2020, but could be wrapped up early next year.

The Manta has generated dumped power from the machine consisting of a 650kg, three-metre-diameter float attached to a 400kg power take-off as a proof-of-concept. The device, made of recycled HDPE, was secured to a buoy and suspended up to 20 metres below the water's surface.

Founder Sam Hetherington said the company has some commercial deals in place for the next stage of Aqua Power Technologies' development.

"Aquaculture is a massive, growing industry and we will probably start to seek deploying arrays of four to eight devices as standalone systems for remote communities," he added. ■

WAVE FLOW CHART – SCOTLAND

Developer	Location	MW	Technology	Type
Installed or due in 2018				
Aqua Power Technologies	Clift Sound, Shetland	0.01	Manta	Wave
Corpower	EMEC Scapa Flow, Orkney	0.025	S3	Wave
TOTAL				**0.035MW**
Scheduled for 2019				
Laminaria	EMEC Billia Croo, Orkney	0.2	Laminaria	Wave
Wello	EMEC Billia Croo, Orkney	1	Penguin WEC-2	Wave
Wello	EMEC Billia Croo, Orkney	1	Penguin WEC-3	Wave
TOTAL				**2.2MW**
CUMULATIVE TOTAL				**2.235MW**

REMOTE POWER: Aqua Power Technologies' 5.2kW Manta semi-submersible wave device in situ at Scottish Sea Farms' Teisti Geo fish farm off Shetland
Photo: Scottish Sea Farms

WaveSub lifeline in wings for Wave Hub

Welsh developer mulling troubled Cornish test site for first full-scale point absorber deployment

Welsh developer Marine Power Systems is eyeing Wave Hub as the deployment site for its first full-scale WaveSub device by 2021. The Swansea outfit had been mulling installation off Pembrokeshire, but is set to make the Cornish test site the home of the at least 1.5MW device.

Wave Hub, which has no active developers at its four-berth, 30MW grid-connected zone, is said to be keen for MPS to deploy its point absorber off Cornwall.

The site has been threatened with mothballing and decommissioning in the early 2020s if no new developers agree to take a berth in the Atlantic.

MPS installed its quarter-scale demonstrator at FabTest off the Cornish port of Falmouth earlier this year following initial testing in Pembroke. The Wave Hub project would be contingent on MPS securing a £15m to £20m Welsh European Funding Office grant. The developer is undertaking the so-called business planning process for the funds, said to be a good sign that support will be forthcoming.

Welsh government sources said funding for between four and six projects from its dedicated marine pot would be signed off by 29 March 2019 when the UK is due to exit the European Union. The remaining projects will account for almost all the €100.4m available from the European Regional Development Fund.

WEFO is said to have received verbal notification from the UK government that the March deadline could be extended until 31 December 2020. If an extension is confirmed, WEFO may invite other wave and tidal players to come forward with proposals to allocate remaining funds.

Other marine players expecting to receive ERDF funding include Nova Innovation, which plans to build a 10-turbine tidal array off the coast of north Wales in the early 2020s. The Scottish company is seeking up to £25m to build the Ynys Enlli scheme, which would feature M100 hardware and a marine subsea hub in the Bardsey Sound.

The project being co-developed with community energy group YnNi Llŷn aims to provide base-load renewable power via an energy storage battery system, likely to be sited in Aberdaron. Nova Innovation plans to submit a marine licence application to Welsh authorities next year to build the array off the Llŷn Peninsula in Gwynedd.

Another developer trying to secure WEFO cash is Anglesey company Menter Mon, which is asking for around £20m for its proposed up to 180MW Morlais tidal demonstration zone. The project, due be online by March 2023, was awarded

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09 £4.2m of ERDF cash by WEFO last year for ongoing consenting work out of a total cost of £5.6m. The total cost of building the Morlais project is pegged at £30m which, as well as WEFO funding, is likely to be assisted by the UK government's £120m North Wales Growth Bid Deal.

Offshore Renewable Energy Catapult, meanwhile, is understood to have secured £5m of WEFO funds for its Marine Energy Engineering Centre of Excellence in Pembroke Dock. Sources said the five-year programme, which aims to employ at least 20 people, would be inaugurated by the end of next year.

MEECE, which will act as a local wave and tidal R&D hub and complement the nearby Marine Energy Test Area, has also secured £4m from the UK government's Swansea City Deal, plus Swansea, Bangor, Cardiff and Cardiff Met universities.

The Marine Energy Wales-led META hopes to secure paperwork to allow testing from next year at various locations in the Milford Haven Waterway.

WINTER LULL: Minesto paused offshore testing of its DG500 tidal kite in the Holyhead Deep off Anglesey in Wales last month. The Swedish developer plans to resume in the spring

Photo: Minesto

Also in Wales, Minesto will resume testing in the spring of its first commercial-scale tidal kite, the 500kW-rated DG500, off Anglesey. In additon, the developer is continuing site development work of an up to 80MW Holyhead Deep tidal project.

Tidal Lagoon Power's plans to build the 320MW Swansea Bay came unstuck in June when UK energy department BEIS decided against granting the scheme a Contract for Difference, on value for money grounds. The project has firm backing of the Labour Party, however, and the Gloucester developer will be watching future political developments with an eagle eye.

In England, US developer GWave plans to formally withdraw its marine licence to install a 9MW Power Generation Vessel at Wave Hub.

Manx Tidal Energy's plans to develop the up to 120MW Point of Ayre, 60MW Langness, and 30MW Kitterland off the Isle of Man, came to end when it and parent company Derillion Energy were dissolved in April. ■

Atlantis to pop cork off Normandy coast

Wider French tidal sector pinning hopes on government energy policy plans out to 2028, writes **Lisa Louis**

Simec Atlantis Energy is aiming to start fabrication of tidal hardware next year for an up to 200MW project off Normandy that is due to be operational in 2021.

The UK developer wants to use the tidal assembly factory in Cherbourg inaugurated by Naval Energies in June, and is in talks with its owner, Shema, a publicly-owned development corporation.

Foundations for the Raz Blanchard scheme featuring Atlantis AR2000 2MW turbines will be manufactured in Le Havre, it is understood.

The company recently signed a partnership with local development agency AD Normandie to set up a French base. Up to 30 people will soon be working at the offices in Caen, sources said.

In addition to the 200MW tidal array in 2021, Simec Atlantis aims to install up to 1GW by 2025 and 2GW by 2027. Chief executive Tim Cornelius believes the plans, submitted to the French government, are "compelling". "We have a local partner with whom we will be able to apply for EU funds, and we will create lots of local jobs," he said.

Atlantis will file paperwork with French authorities "soon" to acquire a concession to build the first 200MW array, he added. "Our investment will be indexed on how confident we feel that the concession will be awarded."

The company is mulling building an initial 20MW pilot in the Raz Blanchard by March 2020, consisting of 10 AR2000 machines. Atlantis is in negotiations with EDF, Engie and the Normandy and French governments about the possibility of acquiring two project concessions in the location.

Sources said they doubt, however, if Atlantis can secure the feed-in tariff and capital grants allocated by Paris with EU state aid approval to EDF's seven-turbine, 14MW Normandie Hydro co-developed with OpenHydro, and Engie's four-turbine, 5.6MW Nepthyd hatched with GE. Atlantis could revive the two paused projects as an equipment supplier, said one.

The company is also keeping a close eye on regulatory developments set to emerge from the central French government, which is finalising the next roadmap dictating outlines of its energy policy until 2028.

The draft document gives tidal the cold shoulder with no mention of tenders but Hydroquest chief executive Jean-Francois Simon said he hopes Paris will amend the plans at the next revision due in 2023. "It would still be alright if they then decided to launch commercial tenders in the following five years," he added.

That timetable would rhyme with tidal developer Sabella's commercial plans. The Brittany company thinks an earlier launch of a tidal tender could jeopardise the sector.

"We are formally and absolutely opposed to a faster development. Tidal technology is just not mature yet and I do not see a reason why France would press ahead with something other countries are not willing to risk either," said Sabella business development manager Jean-Christophe Allo.

The company is lobbying for a tender for tidal test farms with a capacity of about 10MW in 2025, he added.

Independent energy consultant Antoine Rabain insisted Paris should have been more ambitious and launched commercial tenders right away, even if the projects would have been commissioned several years down the line. "It would have been important to send a positive signal to investors and developers that are reaching the final stages of their product development and to give everybody a framework to work with," he said.

GOOD SIGN: President of the Normandy region Herve Morin *(left)* and Simec Atlantis Energy chief executive Tim Cornelius sign off on the Normandie Hydrolienne joint venture at the French Embassy in London last month Photo: Business France UK

The French tidal sector is still reeling from the sudden withdrawal of Naval Energies in July, a month after it inaugurated a turbine factory in Cherbourg.

Chief executive Laurent Schneider-Manoury said the company took the decision with a "heavy heart" after concluding tidal would be unable to compete with solar or wind.

"We felt that France as well as other countries such as the UK, Canada, Japan and Indonesia were just not willing to provide the necessary support to create a commercial market," he added.

Hydroquest's Simon is adamant tidal will eventually become viable. "Naval Energies left the market saying that because they weren't able to bring down costs no one would be able to but that is wrong," he said.

"The market is only about 10 years old. Give us another 10 or 15 years and we will have reduced the costs to under €100 per megawatt-hour."

Cornelius said he believes the market conditions for developing tidal power in France are "as good as it gets. It has a feed-in tariff, concessions in place, access to a grid connection, a wonderful resource and — most importantly after Brexit — access to EU funding." "If you cannot make it work here you cannot make it work anywhere." ■

FRENCH CONTENDERS

Developer	Location	kW	Technology	Type
Installed or due in 2018				
DesignPro	Seeneoh, Bordeaux	25	GKinetic	Tidal
Geps Techno	Sem-Rev, Saint-Nazaire	150	IHES	Wave
Guinard Energies	Arzon, Brittany	3.5	P66	Tidal
Hydro Air Concept Energy	La Rochelle	50	HACE	Wave
HydroQuest	Caluire-et-Cuire, Bordeaux	320	HydroQuest River	Tidal
Sabella	Ushant, Brittany	1000	D10	Tidal
TOTAL				**1548.5kW**
Coming in 2019				
Guinard Energies	Ria d'Etel, Brittany	20	P400	Tidal
Hydro Air Concept Energy	Blanquefort, Bordeaux	200	HACE	Wave
HydroQuest	Genissiat, Auvergne-Rhone-Alpes	2040	HydroQuest River	Tidal
HydroQuest	Paimpol-Brehat, Brittany	1000	HydroQuest Ocean	Tidal
TOTAL				**3260kW**
Slated for 2021				
Simec Atlantis Energy	Raz Blanchard, Normandy	200000	AR2000	Tidal
TOTAL				**200000kW**
Pencilled for 2022				
Sabella	Ushant, Brittany	2000	D12–1000	Tidal
TOTAL				**2000kW**
CUMULATIVE TOTAL				**206.8MW**

Tidal head of steam around France

Hydroquest will install a 1MW full-scale device in April at EDF's Paimpol-Brehat test site in Brittany as French tidal developers step up technology commercialisation.

Fabrication of the double vertical axis Hydroquest Ocean machine is in full swing at Constructions Mecaniques de Normandie's yard in Cherbourg.

The 25 metres by 11 metres-tall device featuring four eight-metre-diameter rotors will sit atop a gravity base foundation.

The Grenoble outfit expects the pilot project to be a forerunner of an up to 20MW array in the Raz Blanchard off Normandy consisting of 10 machines.

The developer will meanwhile commission four 80kW Hydroquest River 2.80 turbines in the harbour of the south-eastern city of Lyon. The 2.04MW Genissiat project in the Rhone River, consisting of a total 39 Hydroquest River 2.80 machines and smaller Hydroquest River 1.40 units rated at 40kW, will follow next year.

Fellow French tidal player Sabella redeployed its D10 1MW turbine back at the Fromveur Passage off Brittany in October.

The machine had been taken out for two years and re-equipped with additional converters and transformers to improve the power output for the island of Ushant.

"That would be the first time a turbine is running for three years in a row. We will test its availability and its power curve," said business development manager Jean-Christophe Allo.

Sabella will also provide two D12 1MW turbines for Akuo Energy's Phares project on the island of Ushant, set to be online by 2022 and including a 900kW wind turbine and a photovoltaic installation with capacity of up to 1MW.

Brest tidal developer Guinard Energies will test a 20kW P154 demonstration turbine off Etel, southern Brittany, early next year.

The company installed a 3.5kW P66 river turbine near the coast of Arzon in Brittany in the spring, and also provided a 4kW P66 turbine for the village of Amboarakely in the African nation of Madagascar, in co-operation with NGO Le Gret and the Malagasy company SM3E. A 150kW P400 turbine is in the making and could be commercialised by the end of next year in Madagascar or French Guiana.

Bordeaux outfit Blue Shark Power, meanwhile, is concentrating on exporting its Blue Shark Pillar tidal technology.

The company has sealed a deal to provide 495 240kW turbines with a total capacity of 120MW for projects in Djibouti in East Africa in co-operation with development partner Weco Weco. The first unit is due to be installed next year. ■

PASSAGE OF TIME: Sabella redeployed its upgraded D10 1MW tidal turbine off Brittany in October Photo: Sabella

HARBOURING PLANS: Hydro Air Concept Energy's HACE wave device to be redeployed off La Rochelle by February Photo: Inter Drones

Wave power makes a noise

Geps Techno's imminent deployment of a wave prototype off Saint-Nazaire marks something of a renaissance for French progress after several quiet years.

The 150kW IHES machine fabricated by Mecasoude, SNEF and finished by Chantiers de l'Atlantique will be shipped to the SEM-REV test site located off Brittany, where it will be trialled for up to 18 months.

The company is hoping to seal a deal next year to build its first commercial device with installation earmarked for 2020.

Chief executive Jean-Luc Longeroche said the Saint-Nazaire outfit is focused on providing modular wave devices of up to 1MW for oil platforms.

"This market is easier to access, as we can obtain prices of up to €600 per megawatt-hour," he added. "Unfortunately, other companies have now realised that and are trying to enter the market whereas just a few years ago we were pretty much on our own."

Another French wave developer, Hydro Air Concept Energy, located near Bordeaux, is aiming for another niche: harbour basins in port locations.

"That makes permitting a lot easier as harbours generally have control over their waters," said executive president Jean-Luc Stanek.

The company's first 50kW HACE prototype is currently being repaired in the harbour of La Rochelle. The device was retrieved following storm damage just a few weeks after commissioning.

The generator will be replaced and the repaired device will be fitted with extra protective measures, plus additional cameras, ahead of scheduled redeployment by next February.

Earlier this year the company bagged its first commercial contract with an order from water provider Tergys in the community of Blanquefort in south-eastern France. Installation of the 200kW device is scheduled to kick off by the end of next year. ■

Corpower weighs EMEC vs Portugal

Wave test site choice will depend on offer of co-funding for Swedish developer's next-gen project

Corpower is pressing full speed ahead on its next-generation wave technology development with plans to install a single 300kW device in 2021 and a further three machines totalling around 900kW in 2022.

The Swedish developer is considering locating the around 1.2MW scheme either off Agucadoura in northern Portugal or at the European Marine Energy Centre in Orkney with a decision due by early 2019. The first installment will be a prototype C4 device currently being designed at Corpower's Stockholm base.

Chief executive Patrick Moller said the design is due to wrap up by next summer with fabrication due to start in the second half of 2019. The first six months of 2020 will be taken up with systems integration of the completed device then dry testing using a new, purpose-built 40 metre-long, 4MW peak load dry rig. Installation is scheduled for early 2021.

The three-device array will consist of C5 machines, which will essentially be C4 machines tweaked through lessons learned from the first deployment, with the same 300kW power rating.

The four-unit project known as HiWave 5 is part-funded via a €8.2m grant from the Swedish Energy Agency. The capex of each device was pegged at between €1.5m to €2m, excluding the cost of building the new dry test rig.

"Our aim is to demonstrate commercially viable wave energy converters, including certification and warranty provision, so that customers can build farms and achieve financial close based on typical finance rather than risk-based grants," said Moller.

The project location will be driven by who is willing to co-fund the Swedish government's investment

The EU-backed Interreg is said to be a possible route to funding a project at EMEC and the under-development pre-commercial procurement programme funded by a €20m Horizon 2020 grant is a "definite option".

Moller said Corpower has support from Portuguese energy company EDP to use the Agucadoura site, the location of the 2008 installation of three Pelamis devices.

The Swedish company meanwhile has provisional turbine purchase deals with Irish developer Simply Blue Energy for potential wave projects off the UK and Irish coasts. "Once accredited by DNV-GL to the level to hand out warranties, that is when their provisional purchase orders become firm."

Elsewhere in Scandinavia, Norwegian

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LIFT-OFF: Corpower C3 deployed at the Scapa Flow nursery site at the European Energy Marine Centre off Orkney Photo: EMEC/Colin Keldie

13 developer Tidal Sails is eyeing alternative locations for the first deployment of its 6MW TackReach device despite gaining consent for installation in the Kvalsund Strait near Hammerfest.

Chairman Are Borgesen said the company is in dialogue with Wavec and other Portuguese organisations regarding a possible relocation of the project off Faro or Lisbon.

Tidal Sails is also eyeing the Sound of Islay in Scotland and other UK waters as a potential option. "Deployment next summer is not possible so the earliest will be summer 2020, which gives us another six months to decide," he added.

Swedish company Waves4Power has all but completed the design of its around 300kW Next Generation device with a view to fabrication and installation off the Norwegian island of Runde.

Chief executive Emil Christiansen said the company has stepped up a fundraising drive to finance a potential deployment of the reduced-cost machine next year.

The superstructure will be made from polyethylene instead of steel, as used in the 42 metre-long WaveEL 3.0 machine installed off Runde last year.

Swedish tidal developer Minesto, meanwhile, is to supply and install two 100kW DG100 kite devices in the Vestmannasund Strait in the Faroe Islands by 2020.

In Denmark, Wavepiston is working on a full-scale demonstration device, having received a €2.5m grant from the EU's Horizon 2020 R&D programme. The two-year scheme will develop an around 185 metre-long device consisting of 24 energy collectors with a total capacity of between 200 and 250kW.

Another Danish wave developer, Resen Waves, is in advanced negotiations to secure a commercial order from an unnamed party to deploy its spring-loaded 'yo-yo' device with tension mooring.

The Kongens Lyngby outfit is targeting commercial development of its technology for offshore oil and gas, plus docking systems for underwater drones for its small-scale device that powers a battery pack on the seabed.

Crestwing installed its 300kW Tordenskiold half-scale machine off Denmark last month. The 30 metre-long device will be tested by the Danish developer for up to two years off Hirsholmene, around 6km north-east of Frederikshavn in the Kattegat Strait. ■

Plans for wave and tidal deployments also taking shape around Europe

NEW BERTH IN THE FAMILY: BT Projects' under construction Tidal Technology Center Grevelingendam in the Dutch province of Zeeland is due to be operational in July 2019 Photo: Dirk-Jan Gjeltema

Netherlands unveils new tidal test centre

The marine industry will welcome its latest test site to the family when the Tidal Technology Center Grevelingendam in the Netherlands comes online in July 2019. Developer BT Projects will resume construction of the three-berth facility at the Flakkeese Spuisluis in Zeeland province on 1 April following a winter storm season break.

Once completed, TTC-GD will consist of three channels of three, six and 10 metres wide respectively, all with a maximum depth of 5.75 metres below sea level and a length of 50 metres. The site will be connected to the grid with a 9.8km cable via a medium voltage substation, it is understood.

BT Projects partner Ferdinand Dees believes TTC-GD presents something of a hybrid solution by offering a test site with tidal conditions and the practical benefits of being part of a sea defence barrier. "TTC–GD will make testing, certifying and validating tidal devices easier and with reduced costs than in the sea," he added.

The site has two developers signed up to deploy devices next year: Pentair Fairbanks Nijhuis is due to install a 1MW horizontal axis screw turbine and Deepwater-Energy a 1MW vertical axis Oryon Watermill.

Elsewhere in the Netherlands, Dutch water authority RWS and the provinces of Zuid-Holland and Zeeland are mulling the incorporation of an up to 50MW tidal scheme in a new flood barrier in the Brouwersdam.

Market consultations kicked off last month ahead of a decision expected early next year on whether to go ahead with the tidal element, which would consist of up to 11 turbines installed by 2024.

In Portugal, AW Energy is due to deploy its first commercial WaveRoller device next year once certification by third party bodies is completed. The company said all WaveRoller components had been shipped from its Finland facility to the harbour site in Peniche, central Portugal, where an onshore substation has been completed by Spanish outfit Abeinsa Engineering.

Across the border in Spain, Tecnalia successfully completed the installation in September of its modified 30kW Marmok A-5 wave prototype at the Bimep test site off the northern harbour of Bilbao. The device was retrieved in June to replace two 15kW Wells turbines with one 30kW bi-radial wave generator.

The machine is due to stay in the water until next summer. Tecnalia, meanwhile, aims to develop a commercial wave machine rated between 250kW and 300kW by 2021.

Republic of Ireland company, Marine Power Systems is due to make a decision early next year on whether it will take up an option to install its quarter-scale WaveSub at the SmartBay test site off Galway Bay.

The Welsh developer secured Foresea funding earlier this year to undertake survivability and performance trials at SmartBay for between six to 10 months.

US developer CalWave is scheduled to install its C1 submerged pressure differential prototype by October 2019 for up to six months. Portuguese outfit UGEN, however, has canned plans to test its oscillating wave column device by the end of 2019.

Cork wave developer Ocean Energy took the wraps off early stage plans last month for an up to 900MW project off the west coast of Ireland.

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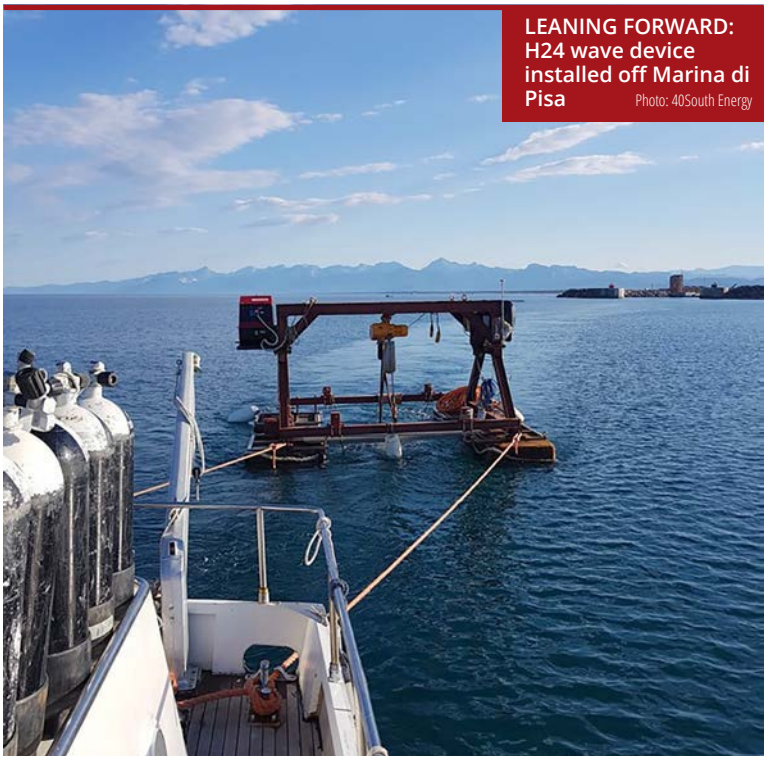


LEANING FORWARD: H24 wave device installed off Marina di Pisa Photo: 40South Energy

15 The Second Shannon Scheme would consist of a 300MW first phase between 2022 and 2032 off Loop Head in County Clare, with a 600MW extension after 2040. Set to feature OE Buoy wave devices, it would be connected via a subsea export cable to the Moneypoint in County Clare.

In Italy, wave outfit 40South Energy started generating grid-connected power in September from its upgraded 25kW H24 machine redeployed in the Ligurian Sea off Marina di Pisa.

German developer Sinn Power is gearing up for the installation of a further three wave devices, each rated at 24kW, off Heraklion on the Greek island of Crete. ■

Ireland gunning to be 'cockpit of innovation'

Positive policy moves are clearing a path for marine renewables including wave and tidal to play a role in Ireland's future energy mix, *writes Stephen Dunne*.

Dublin's mapping of a new renewable electricity support scheme for the 2021–30 period, known as RESS, is an indication of significant commitment to decarbonisation.

Trade body MRIA chairman Peter Coyle said there will be a "huge increase in investment in renewables generation capacity" in the country on the back of RESS.

The scheme recognises that a combination of technologies will be needed and Coyle believes floating offshore wind, which is represented by MRIA, could play a part.

Although wave projects are on a later development arc, most likely post-2030, Coyle said the stated policy position in Dublin is to make Ireland the "cockpit of innovation" in the sector.

This is underpinned by multiple testing facilities that are in place around the coast, as well as several support schemes. The Sustainable Energy Authority of Ireland, which already runs a prototype development fund for wave and tidal, is understood to be mulling additional support. Dublin meanwhile still has a tariff regime of €260/MWh in place for 30MW of wave and tidal.

Elsewhere, a new marine spatial planning draft report is due to be published shortly and come into force in 2021. The document will map a future path for emerging technologies offshore.

However, the one blemish in the copybook is the ongoing failure to publish long-promised offshore consenting laws. Coyle said the understanding is that constitutional issues are holding up publication of the foreshore licensing Bill.

The government is due to receive advice from the Attorney General shortly and has promised to release the laws for consultation as soon as possible. "The lack of a consenting regime is the only dark cloud hanging over the sector so hopefully the sunshine will burst through." ■

Fundy floating into focus

Developers shrugging off industry blues to deploy kit at Nova Scotia test site, writes **Sian Crampsie**

Tidal developers are moving full speed ahead with plans to deploy devices at the Fundy Ocean Research Centre for Energy (FORCE) in Nova Scotia, Canada, despite recent setbacks hitting the industry.

Schottel Hydro subsidiaries Black Rock Tidal Power and Sustainable Marine Energy are aiming to install a demonstrator of its next-generation Plat-I floating platform in the Grand Passage of the Bay of Fundy next summer. The partners plan to start manufacturing an uprated, 420kW Plat-I consisting of six Schottel SIT 250 turbines in the first quarter of next year.

The machine is set to be deployed in a mini-array with its existing four-turbine Plat-I unit, which was installed in the Grand Passage in September. SME said that it is "reluctant" to take its technology straight into testing at FORCE because of the challenging conditions at the site.

"We want to install it in Nova Scotia to create an array in order to understand the operational challenges and train engineers," a spokesman told reNEWS.

The 280kW unit is not currently grid connected and while turbines have been put in place the blades have yet to be installed. SME said the companies will gather baseline environmental data before installing the rotor blades in January ahead of further tests.

The Nova Scotia Department of Energy and Mines issued a permit to Black Rock for the initial testing period of six months under the new Marine Renewable Energy Act regime.

The developer is eyeing a four-unit, 1.68MW array of 420kW Plat-I machines at FORCE berth B in 2020, having dropped plans to install two 2.5MW Triton platforms that would have been made by TidalStream. "The Triton platform was very large and our approach is different," said the SME spokesman. "We are mindful of costs and our aim is to maximise uptime and availability and to take an incremental approach to development."

Irish developer DP Energy is on a project finance drive having secured a C$29.75m grant from the Canadian federal government for its up to 9MW Uisce Tapa project at FORCE.

The funding from Natural Resources Canada's Emerging Renewable Power Program represents up to 30% of project Capex, it is understood, and DP was said to be targeting export credit agencies among other potential investors to help fill the gap.

Uisce Tapa consists of five Andritz Hydro 1.5MW Mk1 turbines at FORCE berth E. The berth is fully consented, grid connected and supported by a 15-year feed-in-tariff set at C$530 per meagwatt-hour, due to expire at the end of 2020.

DP ended plans to install a floating tidal turbine at its other FORCE zone, berth C, after it failed to agree terms and schedule with earmarked supplier Orbital Marine Power of Orkney.

Plans by Cape Sharp Tidal to demonstrate the effectiveness of a 4MW, two-turbine array at FORCE came unstuck in July after French developer Naval Energies pulled the plug on its tidal business.

The move prompted the bankruptcy of its Ireland-based subsidiary, OpenHydro, a partner in the Cape Sharp joint venture with Nova Scotia utility Emera.

Just days before Naval's announcement, Cape Sharp had deployed a second 2MW OpenHydro turbine at berth D. The turbine remains in place but is not operating, according to Emera, which pulled out of the joint venture in August.

Engineers discovered that an internal component failure in the generator had caused sufficient damage to prevent the rotor from turning. "For now, the turbine will remain not turning with the environmental sensors operating," said Emera spokeswoman Stacey Pineau.

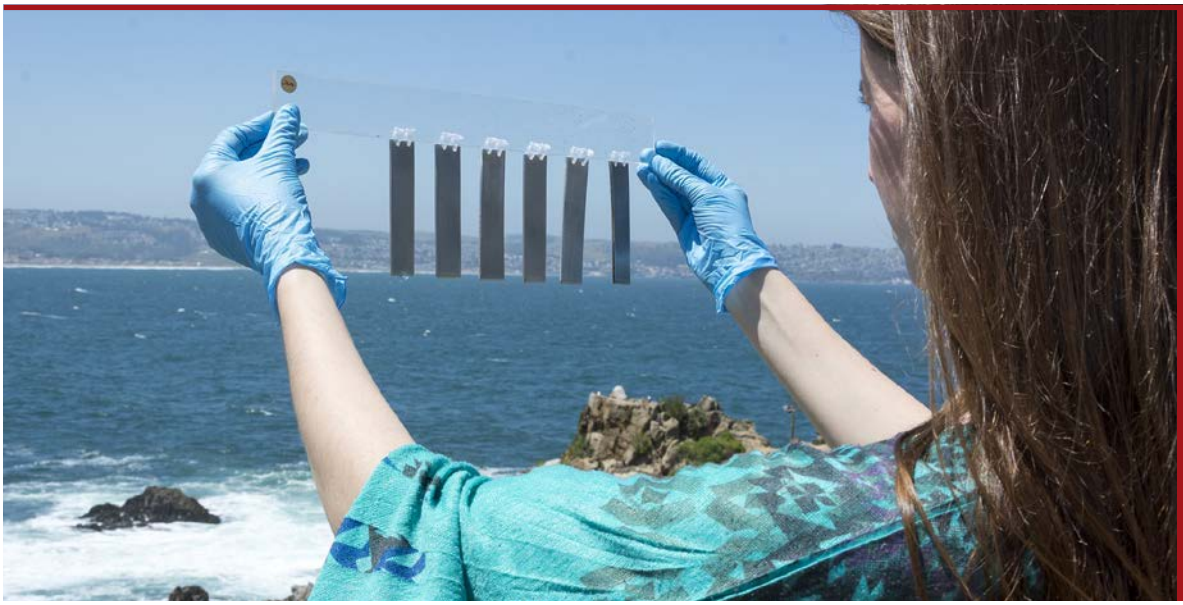
Financial difficulty also put paid to plans by Dutch tidal developer Tocardo to install an up to 1.5MW Universal Foundation System device at FORCE berth A.

The semi-submersible platform with five turbines rated around 300kW was to be fitted by the end of this year, but the company filed for insolvency after a share swap deal with parent company Tribute went sour. ■

CANADIAN COUNT

Developer	Location	kW	Technology	Type
Installed or due in 2018				
Big Moon Power	Minas Passage, Nova Scotia	100	Kinetic Keel	Tidal
Black Rock Tidal Power	Grand Passage, Nova Scotia	280	PLAT-I	Tidal
NeptuneWave	Strait of Georgia, British Columbia	25	Neptune	Wave
TOTAL				**405kW**
Due in 2019				
Big Moon Power	Minas Passage, Nova Scotia	1000	Kinetic Keel	Tidal
Black Rock Tidal Power	Grand Passage, Nova Scotia	420	PLAT-I	Tidal
New Energy Corporation	Bay of Fundy, Nova Scotia	50	EnviroGen	Tidal
TOTAL				**1470kW**
Coming in 2020				
Black Rock Tidal Power	FORCE Berth B, Nova Scotia	1680	PLAT-I	Tidal
DP Energy	FORCE Berth E, Nova Scotia	7500	Andritz Hydro Mk1	Tidal
New Energy Corporation	Bay of Fundy, Nova Scotia	250	EnviroGen	Tidal
TOTAL				**9430kW**
Scheduled for 2021				
New Energy Corporation	Bay of Fundy, Nova Scotia	1250	EnviroGen	Tidal
TOTAL				**1250kW**
CUMULATIVE TOTAL				**12.56MW**

JOINT VENTURE: Sustainable Marine Energy's Plat-I device installed in the Grand Passage of Nova Scotia in Canada for Black Rock Tidal Power Photo: SME



LATIN LESSON: Researchers at Chile's Marine Energy Research and Innovation Centre *(pictured)* are preparing for the deployment next year of the first commercial wave device to be installed off the South American nation. Under an agreement with Meric partner Enel Green Technologies, US developer Ocean Power Technologies will set up a 3kW PB3 buoy. Meric director Luc Martin said the device would be installed off the coast of Valdivia in southern Chile from April and could be in service for between five and 10 years. OPT will evaluate the potential for the device to be used as an offshore autonomous platform hosting oceanographic sensor systems in Chilean waters.

Photo: Meric

Nova Scotia bait reels them in

US tidal developer Big Moon Power is reaching for the stars with plans to build a 5MW array in Canada's Bay of Fundy in the early 2020s.

The Salt Lake City outfit was the first to secure capacity under Nova Scotia's Marine Renewable Energy Act, which offered new permits to test devices in the Bay of Fundy and the Bras d'Or Lakes for a total capacity of up to 10MW.

In April, Nova Scotia awarded a 14-month demonstration permit for a 100kW prototype of Big Moon's Kinetic Keel device and a 15-year power purchase agreement worth C$350/MWh for a 5MW array.

The 100kW, non-grid connected machine was installed in the Minas Passage in the summer and is undergoing evaluation before Big Moon deploys a commercial-scale device earmarked for mid-2019.

The commercial phase of the project, which requires Big Moon to submit an environmental impact assessment to obtain a five-year permit, involves a single 1MW device with a further four 1MW machines to follow.

Elsewhere in the province, New Energy Corporation has applied to the Nova Scotia Department of Energy for a permit to deploy up to 1.6MW in the Minas Passage, at a location close to the FORCE crown lease area. The installation will consist of an array of floating, grid-connected EnviroGen devices based on the Darrieus vertical axis cross flow turbine.

New Energy's proposed project, to be undertaken in co-operation with FORCE, will involve interconnection to the Nova Scotia grid through the test site's substation. This would be the first saltwater commercial demonstration of the EnviroGen device, the design of which has been altered to account for the marine environment.

The Calgary company aims to take a staged approach to its Bay of Fundy project, starting with a pilot device in 2019 consisting of two 25kW turbines. A second phase will scale the systems from 50kW to 250kW in 2020 before full build-out of a further five 250kW units in an array configuration by the end of 2021.

FORCE is providing New Energy with guidance and support for the permit application and has already conducted an analysis of suitable sites in the lease area. The test site will also be engaged for two years to monitor the systems for environmental impact and performance once operational.

On the Canadian west coast, a lack of support for marine energy is holding up New Energy's 500kW Canoe Pass tidal demonstration project in British Columbia.

The Alberta outfit said Canoe Pass is paused because it cannot make an economic case for the project with no incentive programmes in place.

New Energy planned to remove an existing causeway between Maud and Quadra Islands on the BC coast and install two 250kW turbines connected to the local distribution grid.

Still in British Columbia, NeptuneWave is progressing the development of its 1MW wave energy converter, which is currently being tested in the Strait of Georgia.

The device is an updated version of their 250kW Neptune 5B machine, deployed in the Strait of Georgia in February under a five-year 'investigative-use licence from the BC government. Neptune 5B is a 100-tonne wave device with 12 floats spanning 18 metres and rising six metres above the high tide line.

Also in BC, Yourbrook Tidal has signed a project agreement with the National Research Council of Canada for a performance assessment and computational fluid dynamics analysis of a 40kW tidal prototype installed in June 2016 in the Masset Inlet of the Haida Gwaii archipelago.

Yourbrook is advancing the design to make improvements to the mounting, electronic controls and blades. The company aims to scale up the device, culminating in the potential construction and installation of a 1MW grid-connected demonstration project. ■

Bolt runs for commercial finishing line

Fred Olsen is stepping up commercialisation of its Bolt Lifesaver wave technology following the latest deployment at the US Navy's Wave Energy Test Site on the Hawaiian island of Oahu. The around 30kW machine is undergoing a six-month deployment, having been installed in October.

The device was put through its paces via a four-week commissioning phase, operating at reduced power settings to verify system functionality. A previous one-year demonstration of Lifesaver at WETS ended in mid-2017.

Funded by the US Navy, the US Department of Energy and the National Science Foundation, the current project is designed to improve device reliability and power performance.

The deployment also aims to demonstrate an alternative means of powering oceanographic instrumentation without using utility-supplied grid power or single-use batteries.

"We are feeding power to an on-board client sensor system, as well as testing and demonstrating a new capability to circulate 4kW through the winch line down to 10 metres below sea surface," said Fred Olsen engineering manager Even Hjetland.

"We are working full steam on developing a buoy of five metres diameter with one single power take-off winch for simplified installation at deeper waters that can supply 1kW to 10kW of locally produced power to client systems on the surface and on the seabed," he added.

Fred Olsen is targeting the device to be used for subsea oil and gas, offshore wind, defence and oceanography applications.

"We aim to have this product available over the next 12 to 18 months. We are also tendering for commercial contracts in Europe for Bolt Lifesaver following the completion of the current deployment with the US Navy in Hawaii."

Irish developer Ocean Energy, meanwhile, is on track to deploy an OE Buoy wave device at WETS by the summer. Shipbuilding outfit Vigor is manufacturing the 750 tonnes, 38 metre-long device at its yard in Portland, Oregon.

The unit is due to be finished in spring, when it will be towed to WETS for installation. Initially rated at 500kW, it is due to be uprated to 1.25MW once a new Dresser Rand power take-off is fitted after WETS testing is completed.

The $12m Ocean Energy project has received funding from both the Irish and US governments.

Also at WETS, Columbia Power Technologies said it would kick off a grid-connected, open-water test of its 500kW Stingray wave device next year.

Wave developers are in the meantime eyeing the new test facilities in Oregon, due to become operational from 2021.

Oregon State University has partnered with the US Department of Energy and other stakeholders to build the PacWave test centre, which is located between Newport and Waldport.

PacWave operations and logistics manager Dan Hellin said the main focus of current activities is on progressing PacWave South, which will be a grid-connected, pre-permitted test site. "PacWave South is currently in the design and permitting phase," he added.

"The draft licence application for the site was filed with the Federal Energy Regulatory Commission in April and we hope to file final licence applications in early 2019."

PacWave South is expected to be available for deployments from 2021. "We are currently in discussions with a number of developers and test clients but schedules have yet to be decided."

In the tidal sector, Verdant Power recently secured $6m of funding to support the third phase of a project designed to demonstrate, test and commercialise its Free Flow System turbines.

Verdant will deploy its fifth-generation turbine units on a TriFrame mount at the 105kW Roosevelt Island Tidal Energy project in New York City's East River.

The turbines will generate electricity under a hydrokinetic pilot project licence issued by FERC, the first commercial licence issued for a tidal project in the US.

Maine outfit Ocean Renewable Power Company is stepping up development of its next-generation tidal technology. The company will deploy the first production unit of the new 300kW TidGen device in Cobscook Bay, Maine by the end of 2020.

In October, ORPC received a statement of feasibility from DNV GL for the second-generation power system.

In Portsmouth, New Hampshire, New Energy Corporation is commissioning a 25kW tidal device at the Living Bridge project.

The company stepped in to replace another vendor in the project, which will demonstrate power generation at a bridge in a tidal estuary. ■

US SCHEDULE

Developer	Location	kW	Technology	Type
Installed or due in 2018				
Fred Olsen	WETS, Hawaii	30	Bolt Lifesaver	Wave
New Energy Corporation	Living Bridge, Portsmouth, New Hampshire	25	EnviroGen	Tidal
TOTAL				**55kW**
Due in 2019				
Columbia Power Technologies	WETS, Hawaii	500	Stingray	Wave
Ocean Energy	WETS, Hawaii	500	OE Buoy	Wave
Verdant	Roosevelt Island, New York	105	KHPS Gen5	Tidal
TOTAL				**1105kW**
Coming in 2020				
ORPC	Cobscook Bay, Maine	300	TidGen	Tidal
TOTAL				**300kW**
CUMULATIVE TOTAL				**1.46MW**

OH BUOY: Fred Olsen's Bolt Lifesaver Photo: Royer Studios

EMERGING MARKET: Okinawa Institute of Science and Technology Graduate University installed two half-scale wave devices in May at the Holiday Inn Resort Kandooma at South Male Atoll in the Maldives

Photo: OIST Quantum Wave Microscopy Unit

Naval Energies shock waves hit Japan demo

Asian projects still taking shape despite fabrication, funding and regulatory issues, writes **Tim Probert**

Japanese developer Kyuden Mirai Energy is close to pulling the plug on its proposed tidal demonstration project off the Goto islands in Nagasaki province.

Plans to deploy a 2MW OpenHydro turbine in the Naru Strait by 2020 were thrown into turmoil when the fabricator's French parent, Naval Energies, threw in the tidal towel in the summer.

Sources said Kyuden Mirai is trying to find another turbine technology company to step in for the project, co-developed with Nippon Steel & Sumikin Engineering and Nagasaki Marine Industry Cluster Promotion Association.

"The government money is still on the table but we are now two years into a four-year project so timing is of the essence," the source added.

Potential suppliers include Simec Atlantis Energy, which has expressed interest in making a single AR2000 device for the programme. The UK tidal developer signed an agreement with Nagasaki University earlier this year to perform a feasibility study to explore the potential for a number of sites in and around the Goto islands.

Elsewhere in Japan, Wave Energy Technology is stepping up work on its Green Power Island technology with a view to developing a 2MW commercial-scale device.

Director Shinya Noda said the company is in negotiations with potential investors from Japan, China and India with a view to making a 24 metre-diameter machine consisting of four 500kW generators.

The "most probable" outcome is the forming of a joint venture with an unnamed Chinese partner to produce GPI units for deployment in that country, he added.

UK consultancy ITPEnergised, meanwhile, is coming to the end of the design stage of the SG500 tidal device scheduled to be installed next year at a Chinese test site. The 450kW device, based on Marine Current Turbines' SeaGen tidal concept, will be fabricated by project consortium leader China Shipbuilding Industry Corporation.

The surface-piercing turbine, which is being part-funded by central Chinese agency State Oceanic Administration, will be installed at a four-berth test site developed by China Three Gorges in the Zhoushan islands off Zhejiang province.

Other projects due to be installed imminently off the Zhoushan islands include a pair of 300kW tidal machines developed by Guo Dian United Power and Hangzhou Jianghe Hydro-Electric Science & Technology.

The installation of a 300kW horizontal-axis tidal turbine developed by LHD and Blue Shark Power of France off Zhoushan, due this year, has been delayed by weather problems.

Taiwanese developer Aquanet Power,

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Editorial

Editor **Todd Westbrook**
+44 (0)1479 873 167
todd@reNEWS.biz

Deputy editor **Stephen Dunne**
+353 87 760 9207
stephen@reNEWS.biz

Features editor **Tim Probert**
+44 (0)1892 534 478
tim@reNEWS.biz

Reporter **Patrick Browne**
+44 (0)7562 465 668
patrick@reNEWS.biz

France **Lisa Louis**
+33 676 930 784
lisa@reNEWS.biz

Germany **Ross Kelly**
+49 151 6327 3847
ross@reNEWS.biz

Web editor **Robin Lancaster**
+44 (0)7464 930 784
robin@reNEWS.biz

Production
Gavin Ward Design Associates
gavin@gwda.co.uk

Publisher **Dan Rigden**
+44 (0)1962 890 449
dan@reNEWS.biz

Sales

Sales and marketing manager
Vicky Mant
+44 (0)1962 890 440
vicky@reNEWS.biz

Subscriptions manager
Tom Allerston
+44 (0)1962 849 302
tom@reNEWS.biz

Senior sales executive
Cassi Davison
+44 (0)1962 790 460
cassi@reNEWS.biz

Digital sales executive
Stephanie Partridge
+44 (0)1962 890 468
stephanie@reNEWS.biz

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20 meanwhile, said its ongoing project to install a 1MW AirWave machine off Taipei has yet to secure the necessary funding and regulatory support.

Swedish outfit Minesto plans to install a 100kW tidal kite next year off the island of Keelung in Taiwan in tandem with National Taiwan Ocean University.

In south-east Asia, French developer Sabella has placed on hold up to 20MW of projects in the Philippines due to financing delays.

Business development manager Jean-Christophe Allo said the Brittany outfit is struggling to attract the funding necessary to finish the development stage and move on to construction of projects with local outfit H&WB. "We have made resource assessments, design engineering, EIA and permitting work but we need to prove the technology to get the financing. It is a chicken and egg scenario," he added.

Sabella has also frozen its tidal ambitions in Indonesia due to a lack of regulatory support such as power purchase agreements for the technology.

UK tidal developer SBS said it is on track to install the first 12MW phase of what is earmarked to be a 150MW scheme off the island of Lombok in Indonesia.

The company plans to install eight Atlantis tidal turbines on behalf of independent power producer SBS Energi Kelautan by May 2021. The 12MW phase will be followed by expansions to 70MW in the second phase and 150MW in the third and final phase. Output will be sold to PLN under a 30-year power purchase agreement.

Singapore wave developer Hann Ocean is said to be close to finalising a deal with a UAE oil and gas outfit to install three 10kW Drakoo devices to help power a wellhead platform off Abu Dhabi.

The company recently conducted surveys of South China Sea wave conditions around two islands off the Chinese province of Guangdong.

In Malaysia, Finnish wave developer Wello continues to explore plans to install an around 100kW device off the east coast in conjunction with local universities. ■

Aussie funding clouds over Carnegie project

Carnegie Clean Energy will soon find out if the Australian federal government will backtrack on proposed cuts to R&D tax incentives that have imperilled its 1.5MW Albany wave project near Perth. A parliamentary report following an inquiry into the measures has been pushed back from this month to 11 February.

Carnegie was awarded a A$15.75m grant last year by the Western Australian government to design, build and install a single 1.5MW Ceto 6 point absorber device by 2020.

WA made a revised first milestone payment of A$2.625m in August, reduced from A$5.25m, but amid questions about Carnegie's ability to fund the project.

The developer was issued with an ultimatum in early October to provide a detailed funding plan. Upon receipt of the plan in February, WA will assess whether the company has the financial capability to complete the project.

Carnegie non-executive chairman Terry Stinson admitted the project is in serious doubt. "The Australian federal government has changed their funding and our R&D tax credit, which has put a hole in our funding," he said.

"We are currently re-scoping the project to determine if we scale it back or just push back the timeframe," he added.

Elsewhere in Australia, Wave Swell Energy is gearing up to install a 200kW oscillating water column prototype off King Island in Tasmania.

The A$8m project entails the construction, deployment and operation of the WSE device adjacent to Grassy Harbour on the east coast of the island. The unit will be installed in six metres of water depth and will supply electricity to the residents and local businesses.

The operational results will be validated by local power utility Hydro Tasmania, which has a power purchase agreement for the output from the WSE.

The demonstrator is envisaged to be the forerunner to a 1MW, full-scale UniWave machine, and deployment of an up to 10MW pilot array by 2022.

Any subsequent scale-up of the technology on King Island and mainland Tasmania will also see Hydro Tasmania as the commercial recipient of the electricity generated. ■

GOING GREEN: The Oceanlinx 1MW greenWAVE device installed off Carrickalinga in Southern Australia, stranded since it sank during installation in 2014, is to be converted into an artificial reef to benefit marine life

Photo: South Australia Department of Planning, Transport and Infrastructure