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OCEAN ENERGY SYSTEMS

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Policy and Innovation Group

UK Ocean Energy Review 2017

Policy and Innovation Group
The Policy and Innovation Research Group is part of the Institute for Energy Systems (IES), which is one of the six research institutes within the School of Engineering at the University of Edinburgh. The group combines expertise on technologies, energy system organisations and institutions, and the wider policy and regulatory context for energy. They apply a range of quantitative and qualitative research tools and methods including innovation systems, energy system modelling and scenarios, and transitions management. This leads to preparation of strategy and investment roadmaps for organisations' funding, public and private investment and government departments.

Find out more about the Policy and Innovation Group at http://www.policyandinnovationedinburgh.org

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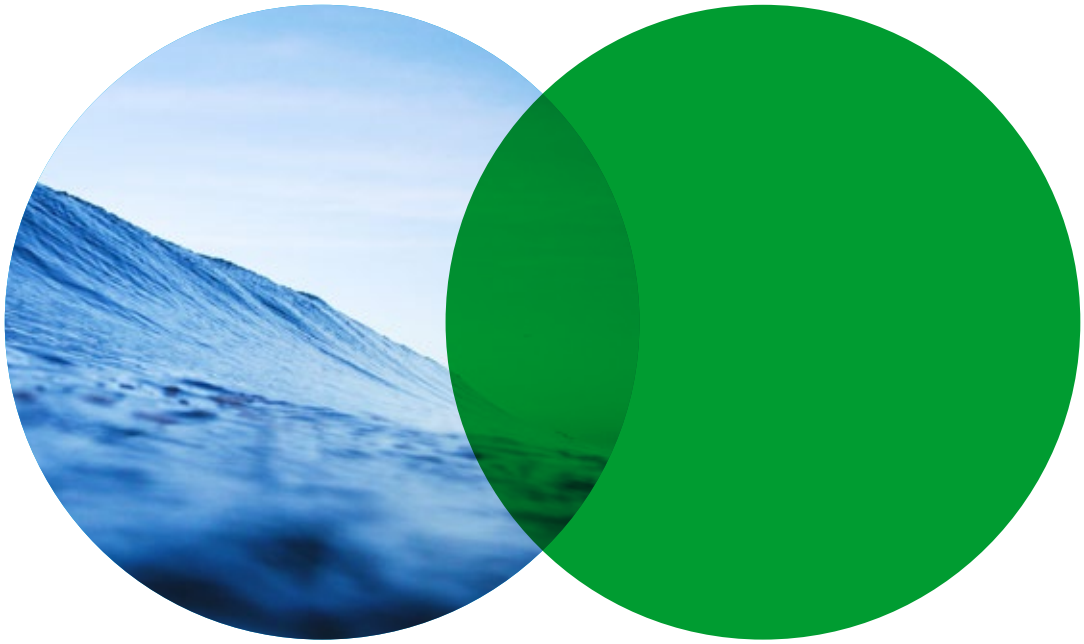

Executive Summary

The United Kingdom (UK) has seen much development in the ocean energy sector throughout 2017. Significant steps towards commercialisation have taken place with the completion of the first phase of two tidal stream arrays, namely the 6MW phase 1A of the Atlantis Tidal Ltd MeyGen project in Scotland's Pentland Firth and the 300kW phase 1 of the Nova Innovation Shetland Tidal Array project. The installation of the Scotrenewables SR1-2000 2MW floating tidal turbine at the European Marine Energy Centre (EMEC) in Orkney in March has helped to contribute to a year of record tidal energy output in the UK, with Scotrenewables production surpassing 1.3GWh in 2017 in addition to production from the MeyGen Array surpassing 2.6GWh by October 2017. In terms of wave energy development there has also been good progress on structured innovation, for example the CEFOW project which installed the first 500kW device in a planned array of three Wello Penguin WECs at EMEC in 2017. This report aims to highlight these achievements and provide a summary of the developments in the UK ocean energy sector in 2017.

2017 has seen the UK collaborating on ocean energy projects with many international partners. Such projects include EnFait, led by Nova Innovation in Scotland and working with nine European partners to extend to the Bluemull Sound Array and study array interactions and optimisation, and NeSSIE, which is led by Scottish Enterprise working with eight European partners to scope three investable anti-corrosion solution projects with the aim of reducing O&M costs for ocean energy. In addition to these, projects such as European Technology and Innovation Platform (ETIP) Ocean and the European Energy Research Alliance (EERA) Ocean Energy Joint Programme aim to encourage knowledge exchange and collaboration within the emerging ocean energy sector within Europe. Meanwhile, political targets for renewable generation continue to increase and develop. In December 2017 the Scottish Government published their Clean Energy

Strategy, setting out key targets of the equivalent of 50% of the energy from Scotland's heat, transport and electricity consumption to be supplied by renewable sources by 2030 and an increase by 30% in the productivity of energy use across the Scottish economy by 2030. The Scottish Government continue to champion the wave and tidal sector and fund Wave Energy Scotland (WES), which has committed over £24m to 61 separate research projects. The Welsh Government also set a renewable energy target in 2017, to generate 70% of Welsh electricity consumption from renewable energy by 2030.

Looking towards the future, the FORESEA and MaRINET 2 calls have resulted in many new planned wave and tidal device deployments for testing at EMEC. Future planned commercial developments include the Fairhead tidal array in NI, planned to begin construction of the 10MW first phase in 2018, and the extensions of the MeyGen Array and the Shetland Tidal Array through the MeyGen 1B and EnFait projects. However, the UK ocean energy sector is still awaiting clear market signals from the UK Government. Under the current CfD auction structure wave and tidal projects have to compete directly with offshore wind, without any additional funds ring-fenced.

Key sector **ACHIEVEMENTS**

- In October 2017 **Atlantis Resources** Limited completed construction of the first phase of the MeyGen project – four 1.5MW turbines, the world's largest tidal stream array.
- Edinburgh firm **Nova Innovation** further extended its Shetland Tidal Array by successfully deploying a third 100kW turbine in February 2017.
- Orkney-based **Scotrenewables** met nearly 7% of the electricity demand of the Orkney Islands over a seven-day period of generation in August 2017 with two 1MW tidal turbines on a single floating structure.
- **Wello Oy** deployed their 500kW Penguin wave energy converter at EMEC in March 2017 as part of the EU Horizon 2020 funded CEFOW project – it has remained on site since installation surviving numerous storms including wave heights of up to 18.7m experienced during storm Caroline.
- In December 2017 WES' funded Stage 3 project **CorPower** Ocean's C3 250kW Wave Energy Converter arrived for at-sea testing at EMEC, due for installation at the Scapa Flow test site in early 2018
- **EMEC** reported a world first by producing hydrogen gas using electricity generated from tidal energy devices (Scotrenewables and Tocardo turbines).
- **EC-OG** tested their Subsea Power Hub (SPH) at EMEC's scale test site from April to November, The SPH combines a tidal energy convertor coupled directly to a lithium based energy storage system, designed to provide power for subsea applications.
- The **final report** was delivered from the UK government-commissioned review of the strategic role of tidal lagoons in the UK, highlighting the benefits of a 'pathfinder' tidal lagoon project.
- **Crown Estate Scotland** was formed, managing a diverse portfolio of property rights and interests in Scotland, including around half the foreshore and the seabed out to 12 nautical miles (nm). Renewable energy interests are managed by Crown Estate Scotland out to 200nm
- **Wave Energy Scotland (WES)** awarded a total of £11m to twenty wave energy research projects during 2017 through their Power Take off, Control Systems, Structural Materials and Manufacturing Process and Novel Wave Energy Converter programmes.

Introduction

2017 has seen much development in the ocean energy sector in the United Kingdom (UK). Significant steps towards commercialisation have taken place with the completion of the first phase of two tidal stream arrays and a range of research, development and innovation projects in wave energy devices progressing throughout 2017. This report aims to highlight these achievements and provide a summary of the developments in the ocean energy sector in 2017.

Whilst the UK has a large proportion of Europe's ocean energy resource, further reduction of technology costs is required for wave and tidal energy to compete with alternative low carbon technologies and contribute significantly to the UK's electricity supply in the run up to 2050. The lack of clear market signals for ocean energy projects is an additional key challenge for the sector in the coming years.

This report presents a non-exhaustive review of the developments and achievements in the field of ocean energy in the UK. The following sections summarise key developments in the UK ocean energy sector in 2017 in terms of the supporting policies, research and development, technology demonstration and future deployments.

Supporting Policies for OCEAN ENERGY

National Strategy

The department for Business, Energy and Industrial Strategy (BEIS) retains overall responsibility for energy policy in the UK although powers related to planning have been devolved to the governments of Scotland, Wales and Northern Ireland. The 2017 UK Government Clean Growth Strategy states that ocean energy technologies "could also have a role in the long term decarbonisation of the UK, but they will need to demonstrate how they can compete with other forms of generation"[1].

The UK government continues to offer revenue support to a variety of renewable energy technologies through the Contract for Difference (CfD) programme[2]. Based on top-up payments to a strike price, CfDs offer long-term price stabilisation and are awarded via competitive auctions. The second round of auctions, worth £290m per annum, opened in April 2017 with results published on 11 September 2017[3]. Strike prices of £310/MWh for wave and £300/MWh for tidal stream were quoted for projects due to deploy in 2021/22 in the BEIS 2017 Draft Allocation Framework[4]. Bids for wave and tidal stream CfD allocations are made in competition with other "less established technologies" in a pot that includes offshore wind and biomass. As shown in the table below the auction results were considerably lower than the draft administrative strike prices, with offshore wind projects gaining CfDs with strike prices of £74.75/MWh for 2021/2022 and £57.50/MWh for 2022/23.

TECHNOLOGY	Draft strike prices		2017 Auction results	
	2021/22	2022/23	2021/22	2022/23
Offshore wind	105	100	74.75	57.50
Advanced conversion technologies (with or without CHP)	125	115	74.75	40
Anaerobic digestion (with or without CHP, >5MW)	140	135	-	-
Dedicated biomass with CHP	115	115	74.75	-
Wave	310	300	-	-
Tidal stream	300	295	-	-
Geothermal	TBC	TBC	-	-

UK Contracts for Difference for less established technologies: Draft strike prices and Auction results (£/MWh)

The Clean Growth Strategy and Budget has confirmed that the £557m remaining in the former Levy Control Framework (LCF) will be allocated to further CfD auctions to 2020, with the next auction anticipated for early 2019[5]. As yet no wave or tidal projects have been awarded a contract for difference, as the previously suggested ring-fencing of 100MW in the LCF for wave and tidal stream projects[6] was not included in the second allocation round. The Offshore Renewable Energy Science and Innovation Audit published in by BEIS in September 2017 noted that: "There is no ring-fenced Contract for Difference (CfD) auction pot for tidal or wave energy, meaning there is currently no clear route to market for innovative companies developing solutions in these maturing technologies"[7].

Scotland

Scotland has substantial ocean energy potential, with a third of the UK's tidal stream resources and two thirds of the UK's wave resources[8]. It also houses the flagship European Marine Energy Centre (EMEC) on Orkney. The Scottish Government remains strongly committed to the development of a successful ocean power industry in Scotland and to maintaining its current strong lead by supporting research, development, innovation and demonstration projects. This was reiterated in the Scottish Energy Strategy, published by the Scottish Government in December 2017, which also included the key target of the equivalent of 50% of the energy from Scotland's heat, transport and electricity consumption to be supplied by renewable sources by 2030[9]. The Scottish Energy Strategy also discussed the new short life industry working group, chaired by the Minister for Business, Innovation and Energy. The purpose of this working group is to agree five priorities to secure the future growth of the marine sector in light of changes in UK Government energy policies and EU exit.

The Scottish Government fund the Wave Energy Scotland (WES) technology programme[10] with the purpose of supporting wave energy technology development. WES funds are committed through a series of strategically targeted innovation projects and research activities, securing intellectual property for the benefit of the industry and driving novel technology development. WES has developed a structured stage gate process for competitive development of wave technologies that provides developers with up to 100% funding through a procurement model. The programme operates a framework for assessing the performance of technology against set standards and metrics to provide transparency and risk reduction. WES is collaborating internationally to create an agreed set of these metrics and have also embarked on a project to introduce structure to the innovative process. WES has now committed £24.4m to 61 separate research projects and is working with 171 separate organisations in the areas of power take-offs (PTOs), novel devices, structural materials and manufacturing processes and control systems[11]. The organisation has recently awarded funding for landscaping projects in electrical connections and moorings and foundations, which will inform any future calls. These will be followed by investigations into the benefits of very large scale wave energy converters and alternative techniques for harvesting of wave energy.

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Wales

In 2017, the Welsh government announced that they had set a target for Wales to generate 70% of its electricity consumption from renewable energy by 2030[12]. In doing so, the Welsh government aims for Wales to become a clean energy centre and actively funds marine and renewables projects. In addition to the positive message given by the Hendry review on tidal lagoons in December 2016[13], 2017 has seen the continued development of two test sites and a number of proposals for tidal stream and tidal range projects in Wales.

Marine Energy Wales is a Welsh Government supported initiative aiming to establish collaboration between developers, academia, the supply chain and the public sector[14]. This is done through regular working groups, including sub-groups dealing with key consenting and research issues. The two ocean energy demonstration zones currently in development in Wales are supported by Marine Energy Wales. In 2017, the West Anglesey Tidal Demonstration Zone received £4.5m in EU and Welsh government funding to support the project consenting[15]. The development of a Welsh marine energy centre of excellence is also proposed, known as the Pembroke Dock Marine Project its aims are to convert an area of Pembroke Dock to a marine energy test area, wave energy demonstration zone and an engineering centre. The Marine Energy Test Area has received £1.9m in EU and Welsh government funding[16].

Photo credit: Scotrenewables

Northern Ireland

The NI Department of Agriculture, Environment and Rural Affairs is working to develop a Marine Plan for NI, with the aim of guiding the regulation, management use and protection of maritime regions[17]. The report will consist of two separate sections for both the inshore and offshore regions and also include a Sustainability Appraisal. The NI Department for the Economy's 2017 Industrial Strategy also includes plans to develop a new Energy Strategy[18].

In 2017 DP Energy's Fairhead Tidal project submitted planning applications, with the first stage of the 100MW tidal stream project aiming to begin construction in 2018[19]. Regional development agency InvestNI continues to engage with the ocean energy sector with a particular focus on finding matches between the sector and the Northern Irish supply chain.

Regulatory Framework

The responsibilities previously held by the Department of Energy and Climate Change transferred to BEIS during 2016 while further work to devolve powers to the governments of Scotland, Wales and Northern Ireland went ahead. In April 2017, the Crown Estate's management duties in Scotland were transferred to the Scottish Government, as recommended by the Smith Commission and reflected in the Scotland Act 2016[21]. Crown Estate Scotland (Interim Management) was formed on 1st April 2017. Crown Estate Scotland manages a diverse portfolio of property rights and interests including four rural estates in Scotland, around half the foreshore and the seabed out to 12 nautical miles(nm) (and renewable energy interests out to 200nm)[22]. Management of seabed rights out to 200nm around Scotland is also vitally important to being able to sustain the competitiveness of Scottish marine industries and to continue to derive wealth from the marine environment.

Photo credit: EC-OG

Public Funding Programs

The Knowledge Transfer Network, operated by Innovate UK, maintains a wide-ranging and up-to-date listing of funding opportunities available in the UK. By far the majority of research and development funding for energy technologies can be found in this database, available at https://www.ktn-uk.co.uk/.
UK organisations which offer funding to ocean energy projects include:

Research Councils UK
The Research Councils UK Energy Programme provides funding for a wide range of technology areas, including ocean energy, covering research and training. It brings together investments from across the UK research councils.
http://www.rcuk.ac.uk/research/xrcprogrammes/energy/

Innovate UK
Innovate UK is the UKs innovation agency and is an executive non-departmental body sponsored by BEIS. Innovate UK works with people, companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy. https://www.gov.uk/government/organisations/innovate-uk

Wave Energy Scotland
WES – fully funded by the Scottish Government – is taking an innovative and unique approach to the development of wave technology in a new research programme. WES brings together the best engineering and academic minds to collaborate on innovative projects that will accelerate the development of wave technologies and encourage the return of private investment.
http://www.waveenergyscotland.co.uk

Research and DEVELOPMENT

Key R&D Institutions

The Offshore Renewable Energy Catapult (ORE Catapult)

The Offshore Renewable Energy (ORE) Catapult is one of seven Catapult centres set up to bridge the gap between research and commercialisation in the UK. It was established by Innovate UK to accelerate the development of innovative technology that will lead to cost reductions in the offshore wind, wave and tidal sectors. Following the merger with the National Renewable Energy Centre (Narec), the ORE Catapult now offers an integrated engineering, research and testing capability for the offshore renewable energy sector. ORE Catapult has collaborated with over 500 industrial and academic partners in its latest financial year, including support to 134 small and medium-sized companies and participation in 35 international projects[23].

Supergen

The Supergen programme was set up in 2001 to deliver sustained and coordinated research on Sustainable PowER GENeration and supply. Supported by The Engineering and Physical Sciences Research Council (EPSRC) through calls and Centres for Doctoral Training, the programme has resulted in greater collaboration between academia, government and industry, the creation of new strategies and innovation programmes and provided an opportunity for international collaboration[24].

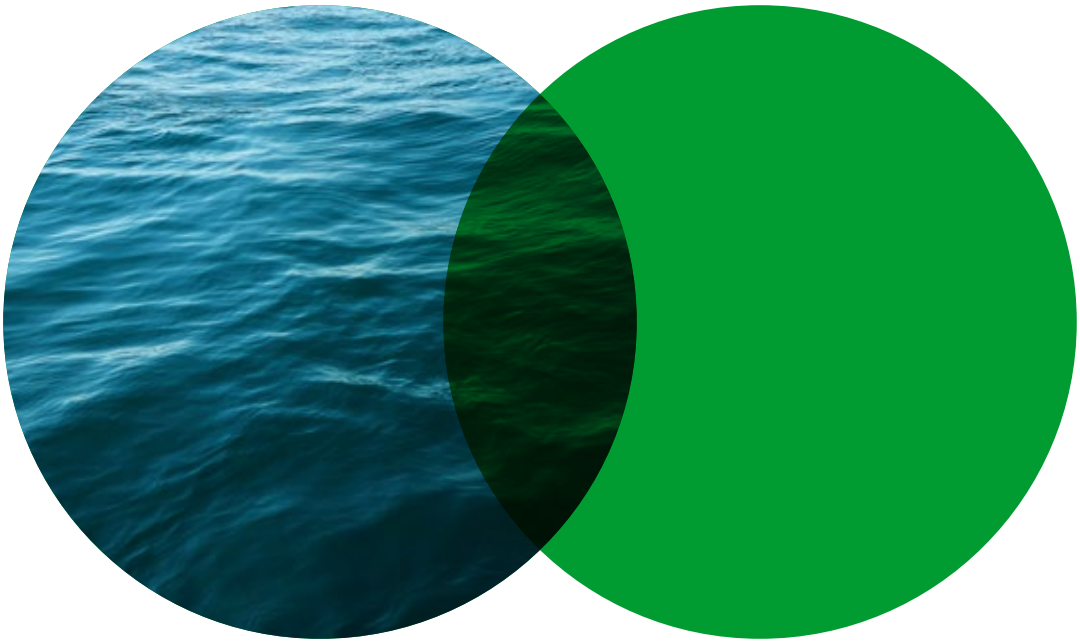
Supergen UKCMER

The Supergen UK Centre for Marine Energy Research (UKCMER) seeks to engage developers, industry, academia and other stakeholders to conduct fundamental and applied research that accelerates deployment of marine renewable energy. Activity across the consortium has resulted in various achievements, including:

- The population and validation of a GIS database of Scottish wave, tidal, offshore- and onshore wind resources as three year projected time series at 3km resolution;
- The development of a wave-to-wire model of an array of wave energy converters to explore the benefits of on-board energy storage for power and speed regulation; and
- The inclusion of component reliability, operation and maintenance strategies, and predictions of device performance in the development of lifetime cost models of classes of wave energy converters[25].

***Supergen* ORE hub**

In 2017, the decision was made to amalgamate the Wind Power and Marine Energy Supergen hubs into a new Offshore Renewable Energy (ORE) hub, as the two sectors were identified as having sufficient common or aligned research challenges as well as synergies in technologies to merit clustering. Consultations with the research community over the creation of the ORE hub are underway to identify a coordinated programme of multidisciplinary research ahead of Supergen Phase 4 funding in 2018[26].



R&D Projects

This section features some example R&D projects undertaken in the UK in 2017, and is not intended as an exhaustive list.

CEFOW

The CEFOW (Clean Energy from Ocean Waves) project aims to deploy an array of three Wello Penguin wave energy converters (WECs) with improved power generation capability at EMEC's grid-connected Billia Croo wave test site. The first of these was successfully installed in March 2017. The project will demonstrate that the WECs can survive in challenging sea conditions over a period of several years. In addition, a cost reduction roadmap will be developed to bring the levelised cost of wave power closer to a commercially viable level in the near future. This project has received funding from the European Union's Horizon 2020 research and innovation programme.
http://www.emec.org.uk/about-us/wave-clients/wello-oy/cefow-clean-energy-from-ocean-waves/

EERA Ocean Energy Joint Programme

The European Energy Research Alliance (EERA) Ocean Energy Joint Programme is coordinated by Henry Jeffrey at the University of Edinburgh. In a Joint Programme (JP) a research organisation joins institutions in other European countries to work on shared priority setting and research projects. The research themes of the EERA Ocean Energy JP are Resource, Technology, Deployment and Operations, Economics and Costs, Environmental and Socio-economic impacts, and Education and Training. An example of the work done by the EERA Ocean Energy JP includes the definition of the scope of the DT Ocean project, in which outputs from work carried out by the Ocean Energy JP fulfilled much of the requirement for background research. https://www.eera-set.eu/eera-joint-programmes-jps/ocean-energy/

EnFAIT

The Enabling Future Arrays in Tidal (EnFAIT) project is a €20.2m Horizon 2020 project which began in July 2017 and will run until June 2022. The project is a partnership of nine European companies and academic partners, led by Scottish tidal energy developer Nova Innovation. EnFAIT builds on Nova's existing operational tidal power station in Bluemull Sound, near to the Shetland Islands in Scotland, which was the world's first grid connected offshore array of tidal energy turbines. It will extend the Bluemull Sound array from three to six turbines and demonstrate that high array reliability and availability can be achieved using best practice maintenance regimes. The layout of the turbines will be adjusted to enable array interactions and optimisation to be studied for the very first time at an operational tidal energy site. https://www.enfait.eu/

ETIP Ocean

The European Technology and Innovation Platform for Ocean Energy (ETIP Ocean) project is managed by Ocean Energy Europe in partnership with the University of Edinburgh and funded by the European Commission. The key aim of ETIP Ocean is to define research and innovation priorities for the ocean energy sector and promote solutions to industry as well as European and national policy makers. In 2017, ETIP Ocean ran ten webinars and events with the purpose of encouraging knowledge exchange and collaboration within the emerging ocean energy sector. https://www.etipocean.eu/

The key aim of ETIP Ocean is to define research and innovation priorities for the ocean energy sector and promote solutions to industry as well as European and national policy makers.

NeSSIE

The North Sea Solutions for Innovation in corrosion for Energy (NeSSIE) project is an EU funded research project primarily focused on the research and translation of cross-industry anti-corrosion technologies in the North Sea basin (NSB) to the offshore renewable energy sectors. Led by Scottish Enterprise, NeSSIE is composed of eight partners over five countries. NeSSIE commenced in May 2017 and will run for two years. http://www.nessieproject.com/

TIPA

The Tidal Turbine Power Take-Off Accelerator (TIPA) project focuses on the testing of an innovative Direct Drive Power Take-off (PTO) solution for tidal turbines, with the aim of reducing the lifetime cost of tidal power by 20%. Running until late 2019, TIPA is led by Nova Innovation and funded by EU Horizon 2020. The project includes accelerated onshore and in-sea testing of a prototype PTO with third party validation and a commercialisation strategy for selling and licensing the product to tidal energy technology developers. Project partners are SKF, Siemens, The University of Edinburgh, Delft Technical University, Wood Group and the Centre for Wind Power Drives RWTH Aachen University. http://www.tipa-h2020.eu/

Wave Energy Scotland

In addition to the projects discussed in this section in 2017 WES funded twenty projects a total of £11m. This consisted of funding three projects a total of £7.5m to go forward to stage 3 of its Power Take Off development programme, four projects a total of £2.84m to go forward to stage 2 of the Novel Wave Energy Converter programme and thirteen new projects a total of £660k in the first stage of the Control Systems for Wave Energy Converters programme. http://www.waveenergyscotland.co.uk/

HIL rig CorPower S3 (Photo credit: CorPower)

Test Sites

The European Marine Energy Centre (EMEC)
EMEC is the only accredited wave and tidal test centre for ocean energy in the world, suitable for testing multiple technologies simultaneously in harsh weather conditions. The centre offers grid-connected test berths at two test sites – one for tidal and one for wave – and also has two scale test sites allowing smaller scale devices or those at an earlier stage of development to gain real sea experience in less challenging conditions.

2017 saw EMEC host six developers: UK-based EC-OG, Nautricity and Scotrenewables Tidal Power, Ireland-based OpenHydro, Netherlands-based Tocardo and Finnish wave developer Wello. Thirty devices from nineteen companies have now been tested on site at EMEC[27].

Scotrenewables Tidal Power commissioned their first full commercial scale machine, the SR1-2000 2MW twin rotor floating tidal turbine at EMEC in 2017. Following first power export in March the turbine quickly set a new tidal sector record, exporting at a peak output of 2.2 MW. The test programme demonstrated the low levelized cost of energy potential of floating tidal energy with all installation and servicing operations implemented with modest multi-cat spec'd or small crew transfer vessels. The SR1-2000 was fully grid connected over the testing period and on average supplied the equivalent of 7% of the Orkney's electricity demand when generating and up to 25% for shorter durations. By the end of 2017 the turbine had generated over 1.3 GWh. Scotrenewables are also working on the next iteration of their technology – the SR-2-2000 – as part of the Horizon 2020 funded FloTEC project[28].

Scotrenewables Tidal Power SR2000 (Photo credit: Scotrenewables)

Green Marine install Wello Penguin at EMEC wave test site at Billia Croo
(Photo credit: Colin Keldie, courtesy of CEFOW)

Also testing at EMEC's tidal test site at the Fall of Warness were: Nautricity, testing their contra-rotating CoRMaT tidal turbine from April to December; Tocardo Tidal Power, testing their T2 tidal turbine from February to December as part of FORESEA; and OpenHydro, EMEC's longest standing client, who continue to test a 250kW scale version of their tidal technology at EMEC[29].

In 2017, EMEC welcomed back Finnish company Wello Oy who initially tested at EMEC in 2012. Wello's 500kW 'Penguin' wave energy converter (WEC) was successfully installed by Orcadian contractor Green Marine in March as part of the EU Horizon 2020 funded CEFOW project, generating electricity into the national grid in April. The Penguin has remained on site since March, surviving numerous storms including wave heights of up to 18.7 m experienced during storm Caroline. As part of CEFOW, Plymouth and Exeter universities completed the first set of ecological surveys, which will be repeated over the following two summers to monitor the cumulative impact of multiple WECs on the seabed habitat and associated ecosystem. A further two Penguin WEC's are due to be installed at EMEC over the next two years as part of the CEFOW project to demonstrate a wave energy array[30].

Aberdeen-based engineering company EC-OG tested their Subsea Power Hub (SPH) system from April to November 2017 at EMEC's Shapinsay Sound scale test site. The SPH combines a tidal energy convertor coupled directly to a lithium based energy storage system, and has been designed to provide power to various subsea applications[31].

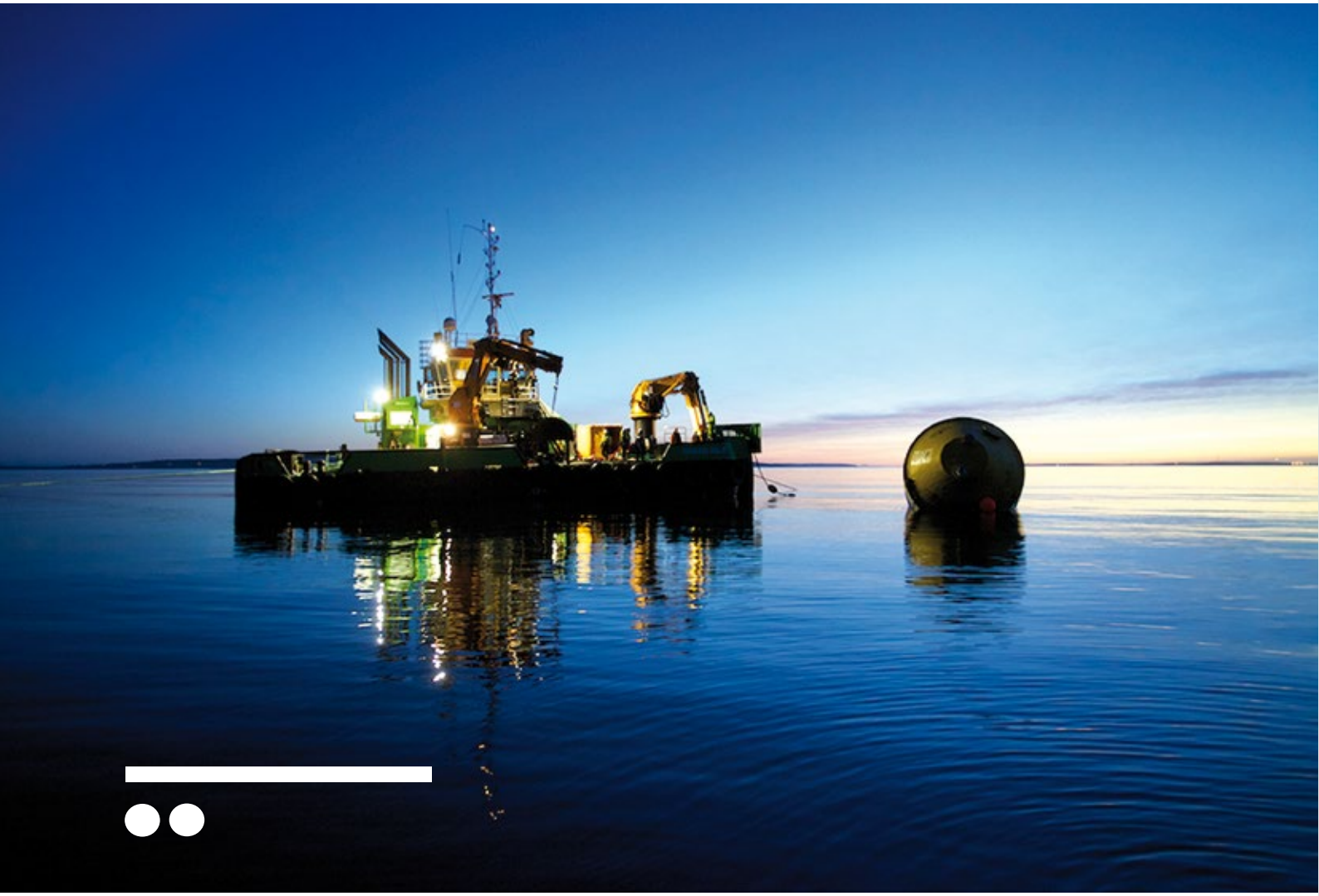


Photo credit: CorPower

Wave Hub

Wave Hub is a pre-installed grid connected site approximately 10 nautical miles (16km) off the north coast of Cornwall for the testing of large scale offshore renewable energy devices. The site has a Section 36 electricity consent and holds a 25-year lease for 8 square kilometres of seabed divided into four separate berths[32]. Wave Hub is owned by BEIS and operated by Wave Hub Limited. In 2016 Seatricity installed their Oceanus 2 wave converter at Wave Hub. In 2017 GWave secured a marine licence for the installation of its 9MW wave energy device, which is planned to be installed in 2018[33].

FaBTest

FaBTest is a 2.8km^2 test site at Falmouth Bay in Cornwall[34]. The relatively sheltered location of the bay allows for smaller and concept devices and components to be tested. In 2018, Australian Marine and Offshore Group (AMOG) will be testing their floating vessel with damped pendulum design WEC[35] at FaBTest and Marine Power Systems Wavesub device will also be deployed[36] at the site.

Technology DEMONSTRATION

Operational Deployments

MeyGen

The MeyGen array, operated by Atlantis Resources in Scotland's Pentland Firth, expanded the array to a capacity of 6MW in 2017, completing phase 1A of the project[37]. In August 2017 the MeyGen project confirmed it has surpassed 1,000MWh of generation onto the grid since project commencement[38]. Funding has been secured for another 6MW of installed capacity in phase 1B. Full capacity across all phases is to be up to 398MW[39].

Nova Innovation Shetland

In 2017 Nova successfully deployed the third 100kW turbine of the Shetland Tidal Array, installed off the coast of Shetland[40], Scotland. The EnFAIT project will extend the array from three to six turbines and up to 600kW[41].

First turbine MeygGen deployment
(Photo credit: Atlantis Resources)

Nova M100 tubine, installed in the Shetland Tidal Array (Photo credit: Nova Innovation)

SME PLAT-I

In November 2017, Sustainable Marine Energy Ltd installed the PLAT-I tidal energy platform at Connel, Scotland. The platform has been fitted with four 70kW Schottel Hydro SIT250 tidal turbines, resulting in a total rated platform capacity of 280kW. The platform will undergo testing in Scottish waters before being transported and deployed in the Philippines[42].

In November 2017, Sustainable Marine Energy Ltd installed the PLAT-I tidal energy platform at Connel, Scotland.

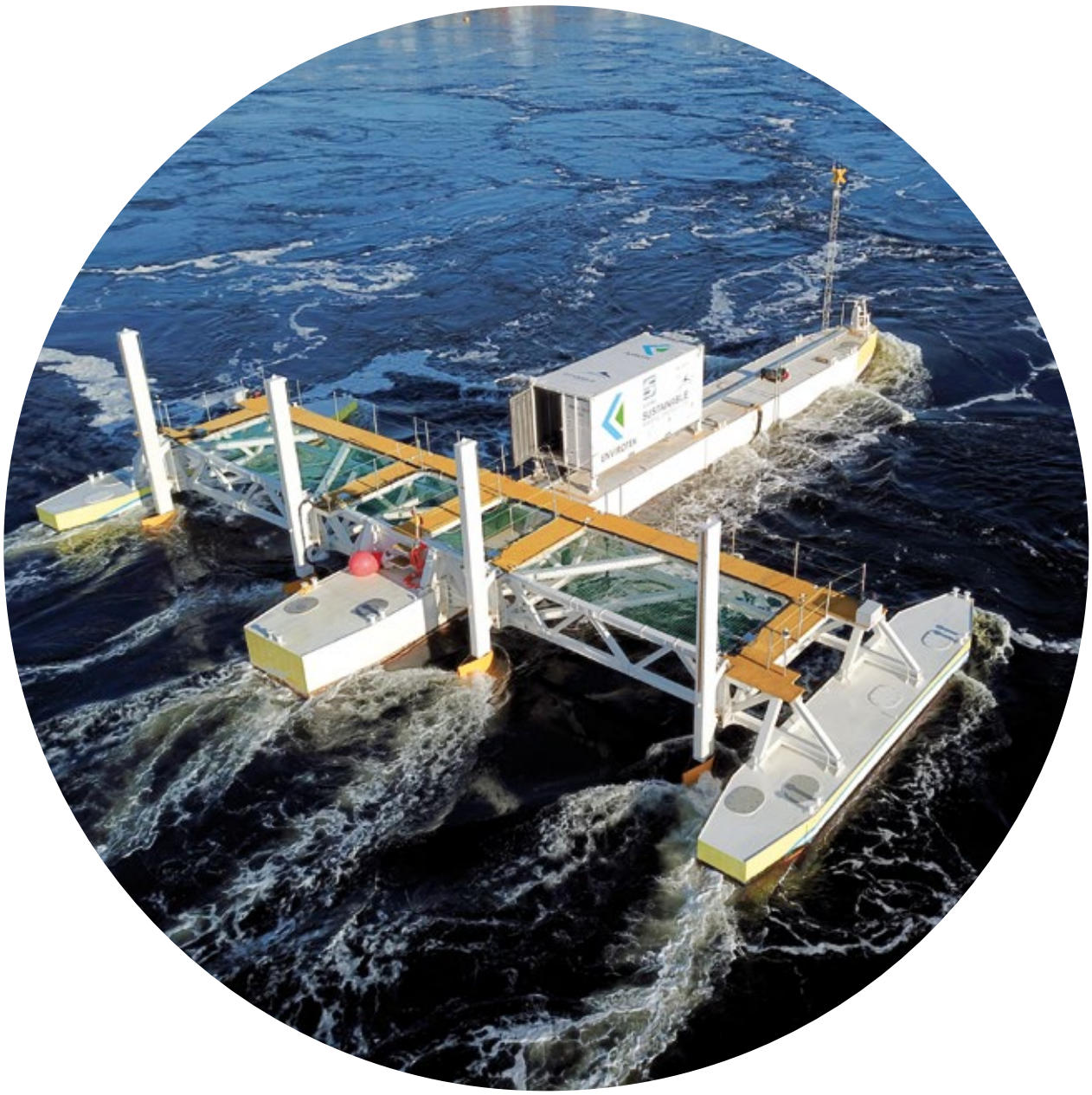


Photo credit: Sustainable Marine Energy Ltd

Photo credit: Nova Innovation

Planned Deployments

Brims
Open Hydro have a 200MW Marine License application submitted and being considered for a tidal development on the north side of the Pentland Firth[43].

EMEC
The FORESEA and MaRINET 2 calls in 2017 instigated a resurgence of wave and tidal developers planning test and demonstration projects at EMEC in the course of 2018. These include CorPower, Laminaria and Magallanes[44].

Enlli Tidal Project
In 2017 Nova Innovation signed an Agreement for Lease with the Crown Estate to develop a 2 MW project in Bardsey Sound, North Wales. The Enlli Tidal Project has been awarded funding by the Coastal Communities Fund, and is currently going through the consenting process[45].

Fairhead Tidal
DP Energy continue to progress through planning and consenting processes with a view to install a tidal stream array at Fairhead in Northern Ireland. The first phase is to involve 4 to 6 turbines with a capacity up to 10MW and is planned to begin construction in 2018. The full scale array is likely to be in the region of 100MW capacity[46].

Holyhead Deep
Minesto plan to install the 500kW Deep Green tidal steam device at Holyhead, Wales in 2018[47].

Katanes Floating Energy Park, Dounreay, Caithness
Floating Power Plant are developing a floating wind/wave development 2.3 km off Dounreay in Northern Scotland. Each floating semi-submersible platform will host a single wind turbine of between 5 and 8 MW and wave energy convertors of between 2 and 3.6 MW capacity, deployment would be split into two phases. A screening opinion was issued in 2017 and an application is expected in 2018[48].

Photo credit: Tidal Lagoon Power

MeyGen 1b

The second phase of the Atlantis Resource Ltd MeyGen Array involves the deployment of another four 1.5MW turbines in the Pentland Firth. Also known as Project Stroma, the phase has been awarded funding support from NER300 and Horizon 2020[49].

Scotrenewables Lashy Sound

Scotrenewables Tidal Power are developing a 10MW array at Lashy Sound in Orkney, Scotland. This array will make use of Scotrenewables' floating tidal turbine concept[50].

Swansea Bay Lagoon

Tidal Lagoon Power Ltd. have plans to construct a 320MW capacity tidal lagoon scheme in Swansea Bay, Wales. Consent was awarded in 2015 and the company plans for construction to begin in 2019[51], dependent on the negotiation of a bilateral CfD with the UK Government.

West of Islay Tidal Park

DP Energy was granted consent in June 2017 for 30 MW of tidal energy development[52].

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