



Wave & Tidal Energy

NETWORK

COMMUNICATION HUB FOR THE WAVE & TIDAL ENERGY INDUSTRY

Research & Development

SPOTLIGHT ON
SOUTH WEST
ENGLAND

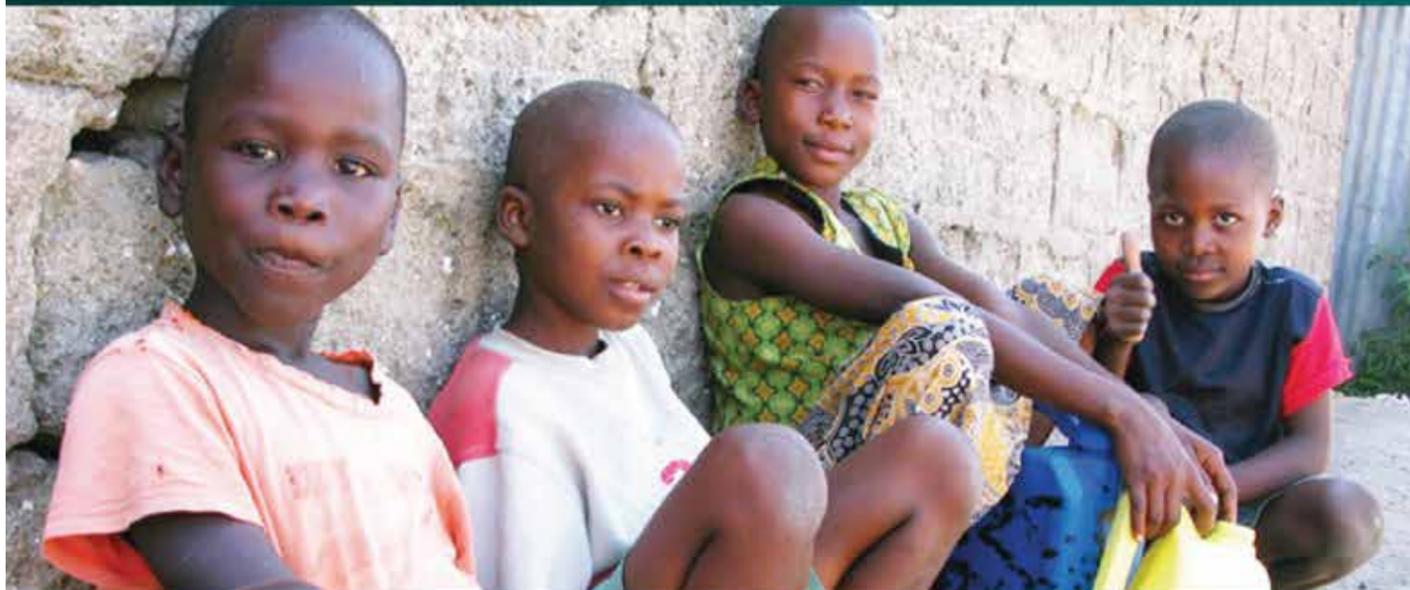
CABLING &
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Industry Updates



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EDITOR'S WELCOME

LEAD BY THE INDUSTRY: FOR THE INDUSTRY

Welcome to Wave & Tidal Energy Network edition 2 – bet you thought it was never going to arrive!

This publication is for the industry and it will be lead by the industry so we want you to play your part in ensuring that this is the best vehicle of communication for all involved in the wave & tidal energy industry.

FOUNDING PARTNERS MEETING

To this end we are arranging a meeting of our Founding Partners at a convenient location/date/time and will therefore be in touch in due course with the agreed dates and an agenda.

EDITORIAL CONTRIBUTIONS

In the meantime, I hope you enjoy the magazine. Feel free to contribute to the next edition. As the industry matures future edition publication dates will be flexible to meet the demands of the supply chain.

Your contributions will be vital to this success so please do not hesitate to get in touch.

SPOTLIGHT ON SOUTH WEST ENGLAND

Another of the areas of the UK who have seen the future possibilities and their respective governing authorities have set ambitious but achievable targets for renewable energy and wave and tidal in particular.

RESEARCH & DEVELOPMENT

Probably the most important subject area to feature in such a young and vibrant renewable energy industry – you will find a fairly substantial feature within this edition.

OTHER FEATURES

You will also find features on Cabling & Cable Protection and Training to name but a few.

FEATURES – GET INVOLVED

As the magazine grows so will the individual features on all sorts of areas within the industry.

These features will emanate from our discussions with leading experts during our visits to conferences and events, as well as our editorial team bringing up subject areas when looking at the industry as a whole.

Please feel free to contact us if there is any subject area which you think may be of interest to our readership and we will do the rest – there is never any charge for genuine editorial.

You will find our 'Forthcoming Features' tab on our website in the magazine section.

MAGAZINE AND WEBSITE INTERACTION – QR CODES

As with our sister publication Wind Energy Network we have pink and green flashes indicating more information online.

QR codes have been substituted in the printed version which means that you can scan the code with your smart phone and it will direct you to the featured company or organisation micropage held within our website, so that you can learn much more in all sorts of formats.

These have already become very popular as it links the printed magazine in a very interactive way – a great marketing tool for our decision making readership to find out about products and services following the reading of an interesting article.



Duncan McGilvray

Duncan McGilvray - Editor
Wave & Tidal Energy Network

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Stonehaven Harbour

The cover image of Stonehaven Harbour was supplied by Maersk Training where the arrival of two new emergency fast rescue craft, signals the imminent restart of a wide range of Maersk Training programmes.

The newly opened Maritime Training Academy, which is owned by their Aberdeen-based partners, Survival Craft Inspectorate will be their base.

STONEHAVEN CENTRE HISTORY

A rescue training centre and voluntary lifeboat had existed at Stonehaven for over 30 years being run by the charity the Maritime Rescue Institute (MRI). However, in December 2013 its fleet of boats and headquarters sustained extensive damage during the high winds, rain and floods which battered the town and it was forced to close.

With tremendous support from Stonehaven Harbour Board and Aberdeenshire Council, the Survival Craft Institute (SCI) has invested a substantial six figure sum in building the new facility and equipment, so as to train its own customers in its emergency marine evacuation systems.

The Stonehaven site includes the main building, offices, classrooms and workshop on the harbour front and an additional building which will be used as a training room - read more in our training feature.

FOUNDING PARTNERS

Without the help and support of our 'Founding Partners' we would not have been able to continue with our 2nd edition - we are arranging a meeting of the 'Founding Partners' following this edition's publication and will therefore be in touch regarding a convenient date/venue in due course.

Duncan McGilvray - Editor
Wave & Tidal Energy Network

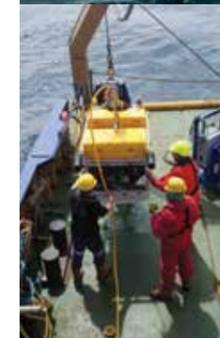
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Industrial Lubricants for the Wave & Tidal Industry

The renewable energy industry continues to grow, with the wave and tidal segment offering great potential. ExxonMobil has been at the forefront of offshore energy sector for over 40 years and has a proven track-record in supporting the development of the wind industry.

CHALLENGES

The company recognises the challenges that Original Equipment Manufacturers (OEMs) face when designing and testing new technologies and understand the importance of considering the role of lubrication from the outset of application design.

Although tidal flows and surging waves provide sustainable means of generating electricity, they also provide a challenging environment for the operation of power generation devices as well as potential increased risks to the people and equipment used to install and repair them. Lubricants for use in wave and tidal energy applications therefore, have to deliver reliable protection and perform optimally in extreme weather conditions, helping to decrease maintenance requirements and reduce exposure to associated risks.

ADVANCED PRODUCTS

ExxonMobil offers a portfolio of advanced products to help renewable energy companies to maximise productivity and improve safety. The hydraulic oil Mobil DTE 10 Excel for example has been developed to protect equipment in harsh operating conditions for extended periods, significantly reducing the requirement for lubricant-related maintenance. Not only does this reduce health and safety risks, but also offers potential financial benefits through reduced repair costs and extended running periods.*

ENERGY SAVING

In addition, Mobil DTE 10 Excel has been developed to offer up to a six percent** energy saving in hydraulic systems when compared to traditional mineral oils. It has also been engineered to have a very low aquatic-toxicity, reducing the impact of the lubricant on the environment and providing peace of mind alongside the focus by OEMs on structural strength and failsafe waterproofing.

ExxonMobil Industrial

**Potential performance benefits relate to the comparison of Mobil DTE 10 Excel to traditional mineral alternatives.*

*** Energy efficiency relates solely to the fluid performance when compared with ExxonMobil's standard hydraulic fluids. The technology used allows up to 6% increase in hydraulic pump efficiency compared with Mobil DTE 20 Series when tested in standard hydraulic applications. The energy efficiency claim for this product is based on test results on the use of fluid conducted in a controlled laboratory environment in accordance with all applicable industry standards and protocols. Actual results may vary depending on operating conditions.*

[Click to view more info](#)



Anything but Silence

BACK IN THE 1960'S, A GENERATION OF ASPIRING OCEANOGRAPHERS, MARINE SCIENTISTS AND ENGINEERS WATCHED WITH GREAT INTEREST TO THE JACQUES COUSTEAU FILM 'THE SILENT WORLD'. HOWEVER, IT WASN'T UNTIL SCIENTISTS DROPPED A HYDROPHONE BENEATH THE WAVES THAT IT WAS DISCOVERED THAT THE OCEANS WERE ANYTHING BUT SILENT!

So much so that the European Union (EU) is driving forward an initiative to regulate the quality of the seas around the shores of its member states.

FRAMEWORK FOR ACTION

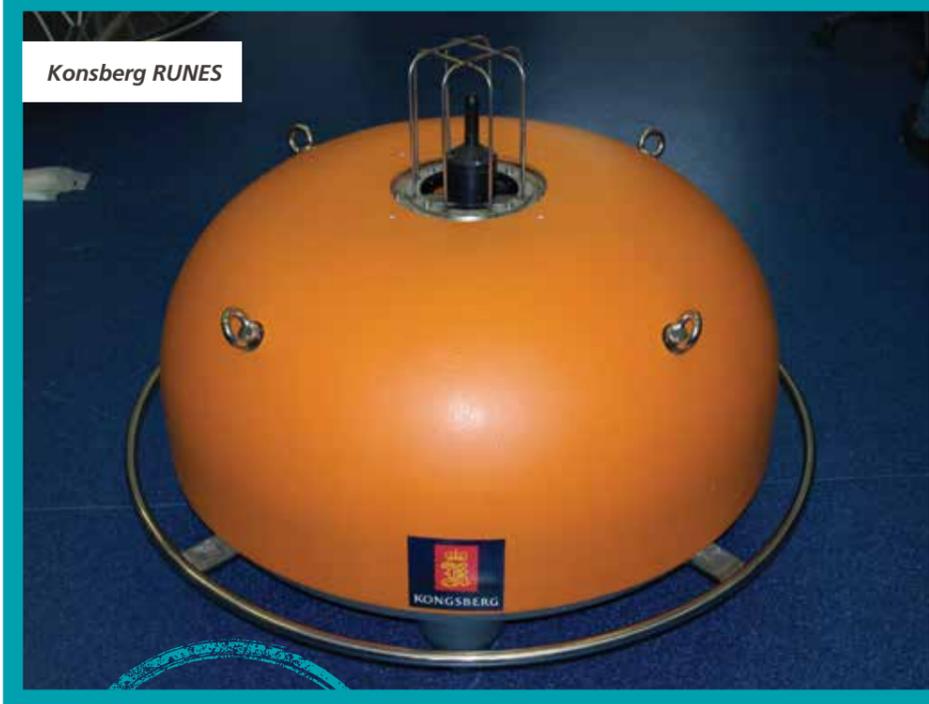
Directive 2008/56/EC establishes a framework for action in the field of marine environmental policy. This is known as the Marine Strategy Framework Directive (MSFD) and was formally adopted by the European Union in July 2008. The MSFD requires the member states to put into place programmes of measures that achieve or maintain Good Environmental Status (GES) in European seas. There are a total of 11 descriptors or criteria against which sea quality is gauged: these cover such diverse factors as marine food web structure, sea floor integrity and contaminant levels.

DESCRIPTOR 11

Descriptor 11 covers the introduction of energy, including underwater noise, to ensure

it is at levels that do not adversely affect the marine environment. It is considered that the underwater noise aspect of this descriptor is perhaps the most challenging of all to be addressed. Hence, a Technical Specialist Group (TSG) was tasked to deliver guidance on definitions against which underwater noise may be assessed. The definitions are given in the box opposite.

Naturally occurring sources such as wind-driven waves, rain, lightning strikes and animal vocalisations generate noise levels are literally swamped with those from impact piling, seismic survey airguns and shipping. Indeed, concerns about the levels of man-made noise and its potential impact on marine life have prompted action at both global and national levels.



Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

11.1. Distribution in time and place of loud, low and mid frequency impulsive sounds – typical sources include impact piling, explosions, seismic airgun discharges

11.2. Continuous low frequency sound – typical sources include vessel noise

REGULATING UNDERWATER NOISE LEVELS

The key to regulating underwater noise levels hinges on the suitability of a noise recorder for the task. Kongsberg have developed acoustic data acquisition systems specifically for monitoring the above requirements. The nature of the application dictates how the system is subsequently packaged and whether any additional processing functionality is required. A number of deployment possibilities may then be considered.

DEPLOYING A HYDROPHONE

At its simplest, a hydrophone is deployed at a suitable depth underwater. The hydrophone is connected via a cable to a laptop or PC running data acquisition and display software. An operator can view and often listen in real-time to the underwater noise. However, it may not be possible or desirable to have personnel onsite 24/7 and operating such equipment in inclement weather can often become impractical.

ALTERNATIVE APPROACH

Autonomous recorders provide an alternative approach. These are systems that, once deployed, remain on site for extended periods of time, logging the acoustic data and either archiving the data for subsequent post-deployment retrieval or else transmitting it to a shore-side location for immediate analysis.

RUNES AND AMBS

Kongsberg have developed 2 such sensors: RUNES and AMBS.

RUNES

RUNES (Remote Underwater Noise Evaluation System) is an ambient noise measurement system that is positioned on the seabed and samples the background noise over an extended period of time. At the end of the deployment period, the unit is recovered and the data is retrieved for subsequent processing and analysis.

RUNES has been used extensively in tasks supporting EIA studies for seismic airgun array surveys and marine renewables development programmes.

AMBS

AMBS (Acoustic Monitoring Buoy System) is a two piece arrangement. The data acquisition and processing unit is located on a deployment platform from which a hydrophone is deployed to the requisite depth. Full bandwidth acoustic data is written to an on-board data storage unit while a decimated data set is transmitted to the receiving unit either locally or globally via satellite communication.

Display software running on the remote PC shows the frequency spectrum as well as the sound pressure level and sound exposure level. This data is written to a log file which can be subsequently form part of an auditable record if required.

The deployment platform can be as simple as a static mooring buoy.

INTEGRATION

Alternative systems include integrating into either an ARGO float autonomous underwater vehicle (AUV) such as REMUS or Seaglider.

Such options lead to a significant increase in the level of operational flexibility. AMBS is ideal for monitoring both impulsive type underwater noise (see Descriptor 11.1) such as that generated during offshore impact piling; and decommissioning using explosives.

Continuous type noise (see Descriptor 11.2) generated by shipping or marine aggregate dredging.

CURRENT EU DIRECTIVES

This article has provided an overview of current EU directives on the regulation of underwater noise levels in the seas of the member states. The review then highlighted the functionality of Kongsberg underwater noise sensors and showed how they are ideal for monitoring noise levels in order to support the directives.

Kongsberg

[Click to view more info](#)

 = [Click to view video](#)

SUMMER REFIT FOR AQUAMARINE POWER

Wave energy company Aquamarine Power has successfully replaced the cylinder module on their Oyster 800 wave machine as their comprehensive summer refit passes the half way mark.

The 23 tonne module was refitted to the 800kW test machine - located at the European Marine Energy Centre in Orkney - in an operation which took just over two days.

IMPORTANT WAYMARK FOR RELIABLE ELECTRICITY GENERATION

"This is an important waymark on our route to reliable electricity generation," says company Chief Executive Officer Martin McAdam.

SIGNIFICANT UPGRADES

"This new module incorporates a number of significant upgrades to the one it replaces - including new check valves, hoses and control and instrumentation. We have worked closely with suppliers Hunger Hydraulik and Calder Engineering to make it robust enough to withstand the extreme forces it will experience during operation."



3 YEARS OPERATION

Martin continued; *"The Oyster concept clearly works - it is the only wave machine to have operated continuously for three winters and has generated multiple megawatt hours of electrical power. Oyster can withstand 100 percent of all sea states and the goal now is to generate electricity reliably. This is a challenge for the whole industry and it is only through full-scale testing can we find out what works, what doesn't and the evolutionary changes we need to make."*

MUCH IMPROVED EFFICIENCY

"This experience is bearing fruit. Last year it took us a week to replace a cylinder and this time we worked with our local supplier Leask Marine to do the job in less than half the time. We're now over half way through this summer's product improvement programme and are still well on track for power production later in the year," McAdam concluded.

Aquamarine Power

MEYGEN PROJECT UPDATE

Atlantis, owner of the world's largest planned tidal current energy project, MeyGen and tidal energy equipment supplier, announced recently that they signed a contract with ABB.

ABB is a leading power and automation technology group, to provide the onshore infrastructure works and electrical equipment for Phase 1A of the MeyGen project in the Pentland Firth, Scotland.

FINANCIAL CLOSE

Atlantis continues to work closely with all relevant financing and contracting parties on achieving financial close for the first phase of the project, which is expected to be completed shortly.

The project remains on track for construction to commence in 2014 with first power expected in early 2016.



Tim Cornelius, CEO

ABOUT ATLANTIS RESOURCES

Atlantis Resources Limited is a vertically integrated turbine supplier and project developer in the tidal power industry.

DIVERSE PORTFOLIO

The Group holds interests in a diverse portfolio of tidal stream development projects, which includes 100 percent ownership of MeyGen Limited, the company developing the MeyGen project in Scotland. The Directors believe that MeyGen is the largest consented tidal stream power project in Europe, is scheduled to commence power production in 2016.

PATENTS PORTFOLIO

Alongside its project development interests, the Group owns a portfolio of patents and patent applications relating to tidal power generation and sells tidal generation equipment and engineering services to third party developers as well as its own projects.

RESEARCH & DEVELOPMENT

The Group, which is revenue generating, also conducts industrial research and development and provides specialist consulting services globally.

Atlantis Resources Limited



ADSR

SLIP RING WITH DIAGNOSTIC SYSTEM



LEINE LINDE SYSTEMS presents the new ADSR, the first slip ring with a diagnostic system for analysing condition and predicting remaining service life.

SERVICE PLANNING MADE MORE EFFICIENT

On and Offshore wind turbines and wave & tidal energy plants are usually geographically distributed and are therefore relatively far from service stations. As a result, unexpected servicing is incredibly involved and expensive.

Thanks to the new ADSR, wind turbine and wave & tidal energy manufacturers, managers and operators will benefit from an advanced diagnostic system – fully integrated into a high quality customised slip ring. The system continuously analyses the condition of the slip ring and predicts an error before it even occurs.

ADSR makes planning wind, wave and tidal turbine maintenance more efficient, making it possible to largely avoid unexpected downtimes and the resulting lost yields.

KEY FUNCTIONS AT A GLANCE

Pitch slip rings, which supply the rotor hub with voltage, signals, data, are subject to wear due to their design. The ADSR's diagnostic system continuously monitors the contact systems and other key functions of the slip ring, enabling condition-based maintenance for optimised value added.

The information and warning messages sent via the diagnostic system are displayed by an LED on the slip ring and made available using network interfaces.

Maintenance personnel benefit from a browser-based web monitor that can be opened anywhere in the world to view the current status as well as meaningful reports and analyses. The slip ring communicates data to customisable interfaces using the OPC-UA industry standard – an especially convenient feature.

SENSORS TO MEASURE A NUMBER OF PARAMETERS

The centrepiece of the ADSR is the integrated sensors for measuring vibrations, the level of voltage and current, number of revolutions, internal and external humidity and temperature.

This systematic monitoring and analysis enables the expected remaining service life of the slip ring to be displayed, both in

terms of time and revolutions. Having this knowledge in advance makes it possible to use up the slip ring's entire service life.

Unforeseeable failures will only rarely occur, which has a positive impact on the efficient operation of renewable power plants equipped with an ADSR.

ADSR LIVE AT WINDENERGY 2014 IN HAMBURG

Thanks to its unique diagnostic system, the ADSR is a smart solution for condition-based maintenance of slip rings in onshore and offshore energy systems. The ADSR slip ring is customised to meet specific individual design requirements and supplied from one single source.

The team from LEINE LINDE SYSTEMS GmbH is giving customers and other interested parties the chance to experience the new product live at this year's WindEnergy 2014 in Hamburg.

LEINE LINDE SYSTEMS GmbH

Wave and Tidal Industry Making Major Progress to Overcome Challenges

Bloomberg New Energy Finance has recently revised down its projections for growth in the global wave and tidal sectors. However, the UK is the world leader in developing marine renewable energy, our developers are continuing to make major progress in bringing these technologies to commercialisation.

MULTIPLE DEVICE ARRAYS

In tidal stream, there are currently three multiple device arrays in the project pipeline, in the Sound of Islay, Pentland Firth and the Skerries, off Anglesey. Proving multiple device arrays will help attract investment in the sector, with plans already well advanced to expand the Pentland Firth array to 400MW by 2020. Major utilities and OEMs are backing these projects.

WAVEHUB

In wave power, the four berths at the Wavehub site off the Cornish coast are already fully booked up as developers seek to prove their technologies. Wave power is attracting interest from major players in the ocean economy, such as shipping company Fred. Olsen and the US Navy.

HIGHLIGHTING THE CHALLENGES

REA Head of Marine Renewables Dr Stephanie Merry said: "BNEF is right to highlight the challenges facing the marine sector at present. First and foremost, these are engineering challenges. The UK has never shied away from such challenges – if we had, we wouldn't have led the world on building sewers, bridges and pumped hydro storage. The marine renewables sector is continuing the extraordinary legacy of UK engineering."

"Once arrays of multiple devices are proven at scale, which is just around the corner, we will also be able to tackle the finance challenge. There'll be less perceived risk for investors and the economies of scale on the larger projects will make them economically competitive with other forms of low carbon generation. These technologies can deliver reliable clean power from our seas for this generation and several to come."

REA



£20K GRANT FUNDING

TO CREATE EQUIVALENT OF GOOGLE MAP OF EAST ANGLIAN SEABED

East Anglian grant programme, Supply Chain innovation for Offshore Renewable Energy (SCORE), has announced Norwich based Norcom Technology as the latest company to successfully receive grant funding.

NORCOM

The £20,000 grant will enable Norcom, which develops software and hardware for navigation and hydrographic survey systems, to develop a desktop and web based application which maps the seabed around the east coast of England.

ECHART SERVICE

Their eChart Service will be created using data derived from material supplied by the United Kingdom Hydrographic Office and will be the most advanced seabed map ever created for the North Sea.

The service will show the precise location of all the current wind farms and proposed future developments, as well as including data pinpointing the staggering 20,000 wrecks on the region's seabed.

INNOVATIVE APPLICATION

This innovative application will be the equivalent of Google maps for the seabed. Users will even be able to do 'passage planning' where it will allow them to enter a destination and will provide them with a route and timings.

STEP CHANGE

Norcom has previously created similar PC based software but this new service marks a real step change for the sector. This also offers companies the opportunity to upload it and overlay additional data to create a bespoke map of the seabed to meet their precise requirements.

Norcom will receive chart and hydrographic data from France, Norway, Germany, Denmark and other European countries to overlay onto the map. Norcom's eChart service is due to be completed by September and the data will then be updated on a three monthly basis.

FUTURE PROGRAMME DEVELOPMENT

Norcom is planning to further develop the programme to be a responsive web based system and in the long term, develop a mobile app version.

Phil Harris, Managing Director of Norcom Technology says: "Receiving funding from the SCORE grant programme was fundamental in bringing this project to fruition. It

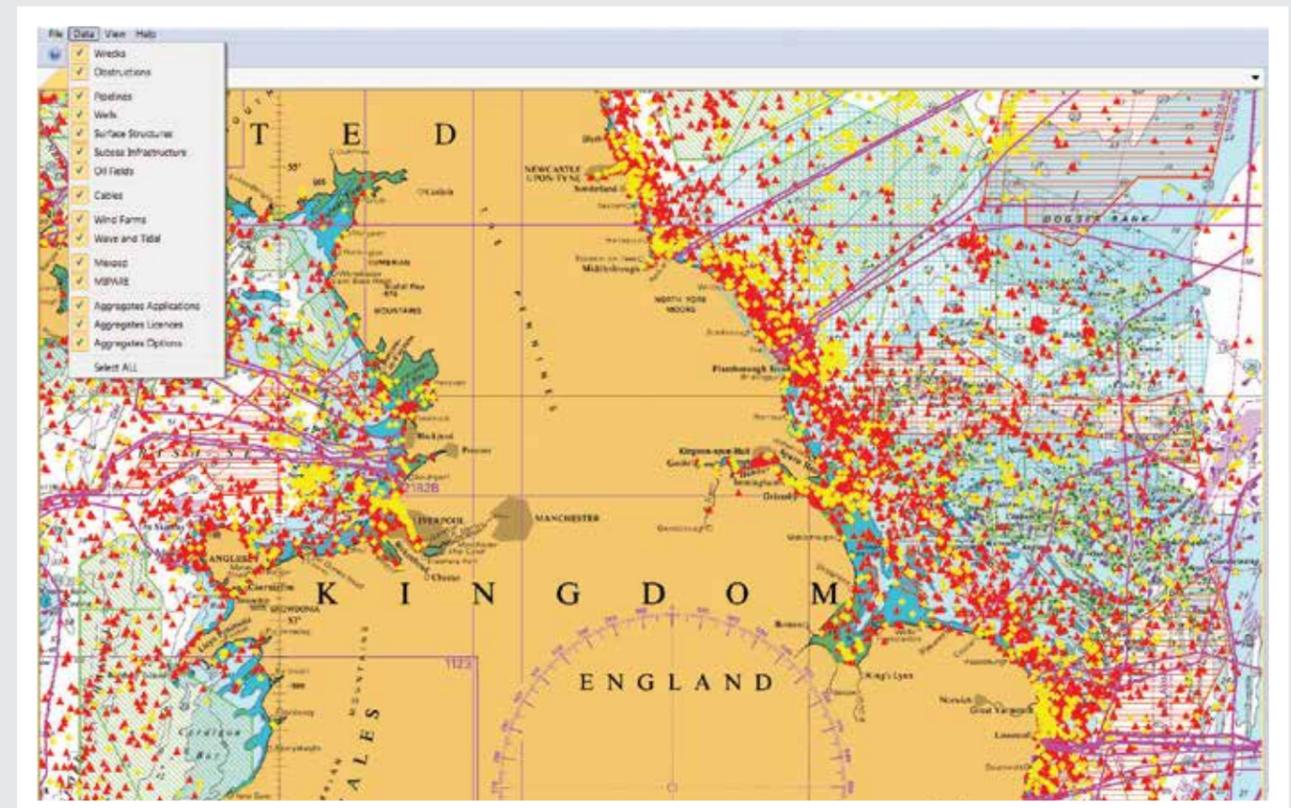
has enabled us to employ a dedicated member of staff to work on the data and web design elements, both of which are critical if we are to complete the service in the timeframe we have set ourselves.

"The funding application process was very straightforward and the monthly approval meeting ensured a quick response, which was really beneficial in enabling us to progress our plans."

SCORE

The SCORE programme delivers a £2.5 million funding investment through the European Regional Development Fund (ERDF). SCORE grants range from £2,500 up to a maximum of 30% of the project's eligible costs, or £50,000, whichever is the lower.

Richard Salmon, Project Manager and business adviser for SCORE says: "It is great to see so much innovation taking place literally on our doorstep. Norcom's service really demonstrates how SCORE funding can make projects happen, whilst at the same time further highlights the region's reputation as the leading UK force within the offshore renewable sector."



GRANT APPLICATION SUPPORT

"We know many SMEs and start-ups can be deterred from applying for funding because of the perception that grant applications are complex and time-consuming. That's not the case with SCORE. Our team of industry specialists are on hand to support companies and start-ups through the process by finding out more about their innovative ideas, evaluating funding viability and then

assisting with the development of a funding business case.

"We hope as we announce further recipients of SCORE funding other potential recipients will be encouraged to contact us. Our region's offshore renewable energy sector provides East Anglian businesses with a unique landscape on which to develop innovative ideas, processes and services and recipients

of SCORE funding will all help strengthen the area's capability for innovation."

Norcom Technology Ltd

SCORE

[Click to view more info](#)

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- The UK's first dedicated port facility for off-shore wind
- 50 acre waterfront development site available

- Trusted business partner with a strong record in port development
- 24/7/365 shipping access




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Contact Belfast Harbour to discuss your opportunity further.
www.belfast-harbour.co.uk/port/wind

GOVERNMENT EARMARKS EAST COAST MARINE AREAS FOR TIDAL STREAM ENERGY

Priority for tidal energy development off Suffolk, Norfolk and East Yorkshire coastlines

The Renewable Energy Association (REA) welcomes the Government's East Marine Plans, approved by Environment Secretary Owen Paterson and published recently by the Marine Management Organisation (MMO).

The Inshore and Offshore East Marine Plans are the first two of 11 Marine Plans the Government intends to complete by 2021. These will eventually set planning guidance for sustainable development in all English coastal waters.

EAST MARINE PLANS

The East Marine Plans designate several areas of high tidal stream resource off the East Yorkshire, Suffolk and especially Norfolk coastlines where tidal energy development will be prioritised.

Other developments in these areas will have to be justified to the MMO, any adverse impacts on tidal energy development minimised or mitigated. The REA has played a key role in ensuring that wave and tidal energy is supported under the Marine Plans programme.

MMO SUPPORT

REA Head of Marine Renewables Dr Steph Merry said:

"We have been working hard to highlight to Government the non-financial barriers to wave and tidal energy in UK waters. These provide opportunities for cost-effective policy measures that will support this nascent green industry at minimal cost to the taxpayer."

"The kind of excellent support the MMO has demonstrated is very much needed if we are to preserve our world-leading position on wave and tidal energy."

THE CROWN ESTATE

The Crown Estate has also demonstrated leadership in developing practical measures to boost the marine energy industry, such as funding open access wildlife surveys for the benefit of the sector as a whole, reducing the burden on developers to fund their own surveys duplicating those of their competitors.

NUMBER ONE ISSUE

Dr Steph Merry continued:

"The number one issue for the marine sector is ensuring there is room for growth for wave and tidal energy under the new Contracts for Difference scheme – for instance, by setting minimum deployment thresholds. It is vital that developers can access state support in order to get over the commercialisation hurdle, scale up development, create more jobs and further bring down the technology costs."



PRACTICAL MEASURES

The REA has also called for similar cost-effective, practical measures such as...

- Assuring support for wave and tidal in the Government's EMR programme, via guaranteed capacity in the Contracts for Difference scheme
- Providing all projects equal access to the grid at a reasonable rate
- Ensuring the Offshore Renewable Energy Catapult programme for the sector is effective
- Joint procurement and installation
- Green Investment Bank involvement

JURISDICTION

The East Marine Plans cover the coast and seas from Flamborough Head to Felixstowe, with a major area earmarked for tidal energy development off the Norfolk coast near Great Yarmouth.

They also contain similar policies for offshore wind. The next Marine Plan will cover the South Coast, from Folkestone to Dartmouth. The REA will continue to engage with the MMO to ensure that all future Marine Plans also support the UK's efforts to reduce greenhouse gas emissions and boost energy security with marine renewable energy.

REA

INNOVATIVE WAVE ENERGY CONVERTER RECEIVES SCORE GRANT

Marine Power Systems' innovative WaveSub is the latest project to receive funding from grant programme, Supply Chain innovation for Offshore Renewable Energy (SCORE).

WAVESUB

Marine Power Systems was founded to develop and bring to market the novel, patent protected wave energy converter 'WaveSub'.

KEY USPS

Award winning WaveSub's four key USPs all work to overcome the challenges facing those trying to exploit wave energy...

- 1 It addresses the difficulty of harnessing power through its advanced energy capture system
- 2 It has excellent survivability
- 3 It is quick and simple to transport, install and maintain
- 4 It has a low capital cost

SCORE GRANT

The £9k SCORE grant is being used to secure intellectual property rights in this key period whilst Marine Power Systems' seek further funding to develop the WaveSub and manufacture a prototype.

Dr Gareth Stockman, Managing Director of Marine Power Systems, commented: *"SCORE funding is integral in enabling us to leverage further investment. Applying for the funding was straight forward and swift compared to other grant applications and we received approval quickly too."*

SCORE PROGRAMME

Richard Salmon, Project Manager and business advisor for SCORE says: *"SCORE funding is still available, so we urge anyone with an innovative idea to benefit the offshore renewable sector to get in touch."*

The SCORE programme delivers a £2.5 million funding investment through the European Regional Development Fund (ERDF). SCORE grants range from £2,500 up to a maximum of 30% of the project's eligible costs, or £50,000, whichever is the lower, and are available to all East Anglian based SMEs in the renewable energy supply chain.

Marine Power Systems

SCORE

[Click to view more info](#)



Design and Engineering of the Wave Hub Project

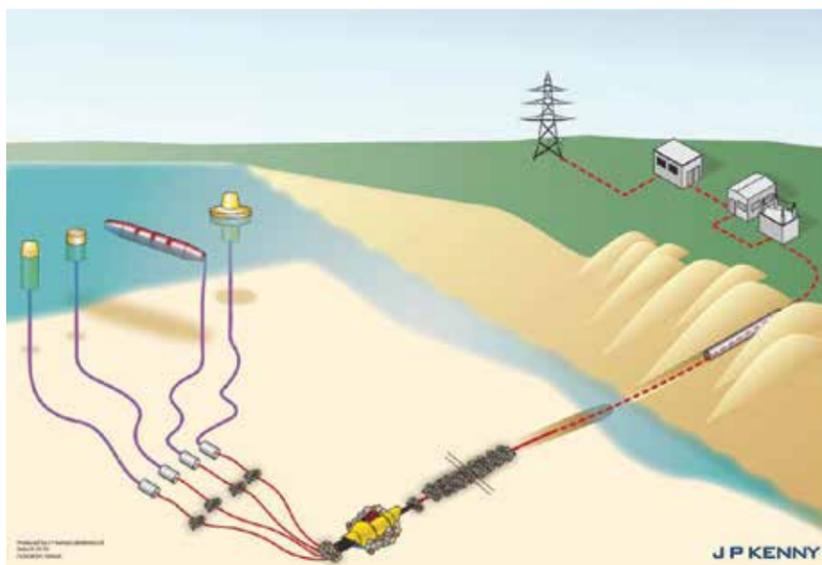
THE WAVE HUB PROJECT POSED A NUMBER OF UNIQUE ENGINEERING CHALLENGES IN THE DESIGN OF THE OFFSHORE FACILITIES AND SUBSEA POWER CABLE (SPC), IN PART DUE TO THE NATURE OF THE DEVICES THAT WILL CONNECT TO THE WAVE HUB, BUT ALSO DUE TO THE HIGH ENERGY ENVIRONMENT IN WHICH THE INFRASTRUCTURE WAS PLACED.

WOOD GROUP KENNY WERE RESPONSIBLE AS PROJECT MANAGEMENT CONTRACTORS FOR THE ENGINEERING AND CONSTRUCTION OF THE PROJECT.

WAVE HUB OVERVIEW

The Wave Hub system comprises of four WEC developer berths in approximately 50 metres water depth. The seabed in this region is predominantly rock.

The most critical phase of the project was the establishment of the overall concept for a system that could safely accommodate four arrays of disparate generators with the lowest cost and schedule risk.



OPTIONS

A number of options were considered for the configuration of the SPC and related infrastructure. The main criteria employed for conceptual evaluation and assessment (in no particular order) were...

- Reliability and availability
- Redundancy
- Technical/commercial risk
- Maintenance requirements
- WEC connection requirements
- Capability of multiple voltage throughput
- Technology readiness
- Future proofing
- CAPEX and OPEX
- Schedule

ELECTRICAL CONSIDERATIONS

The design of the cable was integral to the overall conceptual design. Electrically, the ideal solution would be to have individual cables running to each berth.

HUB

The hub is a subsea junction box, where the twin triads of the main power cable are split out. These two triads then each serve two WEC berths via four 'Tails'.

In order to minimise cost, the hub structure was designed as a maintenance free gravity based structure protected by rock dumping.



However, due to the length of the route (~25km) and the complexities of protecting cables in a high energy environment the cost of a four cable solution was prohibitive. Therefore, a single cable incorporating twin triads was chosen. This had the advantage of being relatively quick to install and protect.

CHALLENGE

One challenge was the on-bottom stability of the subsea cable and hub. Even with twin armour layers, the SPC was not stable on the seabed. A variety of options were considered to increase the cable weight.

However, the increase in weight required to render the cable fully stable on the seabed would significantly increase the cost, as well as the manufacturing time and limit the number of vessels that would have the capacity to install it.

SEABED CONDITIONS

The rocky nature of the seabed also resulted in the possibility for several hundred freespan (unsupported lengths of cable) which may lead to cable damage as well as being a fishing hazard.

Therefore, rock dump was selected as the best method to achieve both cable protection and on-bottom stability with additional protection provided by flexible concrete mattresses.

Wood Group Kenny

Completion of Submarine Asset Survey for Wave Hub

CONTRACT AWARD

Coastline Surveys was delighted to be awarded the contract to carry out the submarine asset survey including multi beam bathymetry and side scan sonar, ROV visual inspection and cable burial surveys.

Additional geotechnical investigations were undertaken in test berth 4 to assess the seabed nature for future anchoring of proposed test devices. The surveys for this important renewable energy site were successfully completed in 2013. Not only is this an important renewable energy project with which to be involved, it is also located right on the doorstep of Coastlines' head office in Falmouth.

3 PHASE PROJECT

The project was split into 3 phases to make the most of the MV FlatHolm's unique capabilities to carry out all three elements of the scope of works. The geotechnical investigation was carried out first – comprising vibrocores at each of the proposed anchor locations in Berth 4.

The vessel was then switched to geophysical mode to complete phase 2 - the full cable length bathymetric survey. Phase 3 comprised the ROV operations including the visual and cable burial surveys.

CHALLENGE

The biggest challenge to the project was the strong tidal streams on the site which restricted the window of operations for the ROV work. Using the more powerful Cougar XT was a benefit in being able to extend the window of operations.

Excellent vessel handling skills by the dedicated Flatholm crew also maximised productivity during this phase of operations. The ability to remain on site for up to 7-10 days duration enabled maximum use of the working windows with minimal time lost for transit back to port.

EFFICIENT AND COST EFFECTIVE SOLUTION

By breaking down the project into phases Coastline was able to offer an efficient and cost effective solution with a platform that was able to complete the entire scope of work from very shallow inshore operations out to the offshore end of the project.

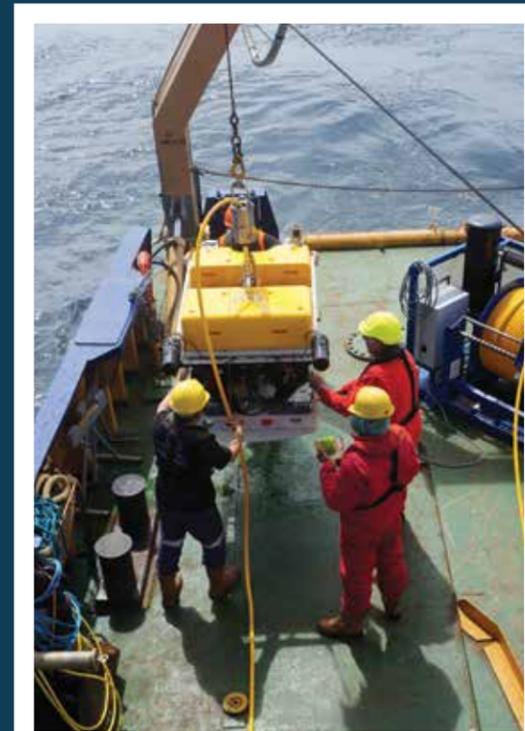
All operations were completed within anticipated timescales on site whilst maintaining their enviable safety record.

Coastline Surveys

R2Sonic 2024 Multi Beam Echo sounder together with a Klein 4200 dual frequency Side Scan Sonar. A cable burial survey was carried out on the inshore 8km of the cable.

The cable burial survey was completed with an Innovatum Smartrak cable detection system following a tone applied to the cable. The Smartrak system was mounted on a Cougar XT ROV which was also used for the video inspection element of the works.

Surface positioning was provided by a C-NAV 3050 GNSS System and subsurface was provided by a Nexus Easytrak USBL



WAVE HUB IS A GRID-CONNECTED OFFSHORE FACILITY IN SOUTH WEST ENGLAND FOR THE LARGE SCALE TESTING OF TECHNOLOGIES THAT GENERATE ELECTRICITY FROM THE POWER OF THE WAVES. IT IS ABOUT 10 NAUTICAL MILES OFFSHORE AND IS DESIGNED TO HELP COMPANIES DEVELOPING NEW WAVE ENERGY DEVICES.

The UK has some of the largest wave and tidal energy resources in Europe which in the right circumstances could generate up to 1/6 of the UK's electricity consumption.

Cornwall and Finistère Top of the Agenda at European Conference

The latest exciting developments taking place in the marine renewable energy sector in both Cornwall and Finistère were top of the agenda at the Marine Energy in Far Peripheral and Island Communities (MERiFIC) conference held in Brest in France earlier this year.

MERiFIC PROJECT

The pioneering MERiFIC project, which is led by Cornwall Council, aims to increase the adoption of marine energy across Cornwall and Finistère. The one day conference, which was attended by representatives from the marine energy sector from both regions, also provided an opportunity for the audience to hear first-hand about the positive results coming from the collaborative work in a range of key areas.

PIVOTAL MOMENT

Julian German, Cornwall Council's Cabinet Member for Economy and Culture, who was one of the key note speakers at the event held at Océanopolis, said *"Both Cornwall and Finistère regions are at a pivotal moment in their history as we are now going to test pre-commercial Marine Renewables Energy devices."*

"I am confident that as a result of the hard work and collaboration from both Cornwall and Finistère, we have now put ourselves in the best position to be able to make real benefit from the marine renewable sector. From supply chain to deployment, we have a great deal of expertise to offer and international interest is increasingly strong."

KEY ISSUES INSIGHT

The conference also provided an insight into the key issues currently being discussed by policy-makers and information on the tools that will support the growth of the marine energy sector at regional level.

Nicolas Wallet, MERiFIC Project Manager said: *"MERiFIC supports Marine Renewable Energy in far peripheral regions and islands and communities, by creating an economic development strategy that includes technological, environmental, political environment and the stakeholder engagement."*

THE CONFERENCE FOCUSED ON FOUR MAIN THEMES...

- Technical and environmental issues – wave resource mapping, environmental impact assessment, marine operations
- Policy issues – financial incentives, barriers to development, health and safety
- Regional impact of MRE – supply chain, skills, regional strategies, MRE projects in the pipeline
- Stakeholder engagement – tools, case studies, best practice in working with stakeholders in the development of MRE arrays

Cornwall Council



ROTABOLTS

For Wave Power Project

Aquamarine Power has ordered RotaBolt measurement technology for its Oyster 800 wave power project which captures the energy in nearshore waves and converts it into clean sustainable energy. The fasteners will be fitted to an underwater flange that is part of the system's main 'water hydraulics'.

WHY ROTABOLT?

"There were two main reasons why we have ordered RotaBolt technology," commented Richard Montague, Lead Mechanical Engineer, "We needed to be confident that we were achieving the correct bolt tension on this pipe flange to assure its operational integrity. We also wanted to make maintenance checks as simple and quick as possible.

"Through experience of using RotaBolt technology before joining Aquamarine Power, I hope our divers will be able to carry out checks for correct tension without re-torquing. This will be a significant maintenance benefit."



THE TECHNOLOGY

The technology incorporated into each RotaBolt fastener assures that the correct tension is achieved at installation and then throughout the life of the bolted joint. The design features a RotaCap on the top of the bolt which allows for instant finger-tip checking of correct tension, making it ideal for applications where operators are looking for operational integrity and also maintenance savings.

OYSTER 800 PROJECT

The Oyster 800 project is situated off the Orkney Islands and has been operational since 2012. Essentially it is a wave powered pump consisting of a buoyant, hinged flap which is attached to the seabed at depths of between 10 and 15 metres, around half a kilometre from the shore.

The hinged flap, which is almost entirely underwater, pitches backwards and forwards in the nearshore waves. The movement of the flap drives two hydraulic pistons which push high pressure water onshore via the subsea pipeline to drive a conventional hydro-electric turbine.

CONTINUOUS PROGRESS

The project is being continually refined and improved by Aquamarine Power and it is expected that next winter's weather will provide a fuller testing of RotaBolt's ability to assure integrity, before a final

assessment is made next spring. The hydraulics system has a number of flange connections which could potentially also benefit from RotaBolt technology.

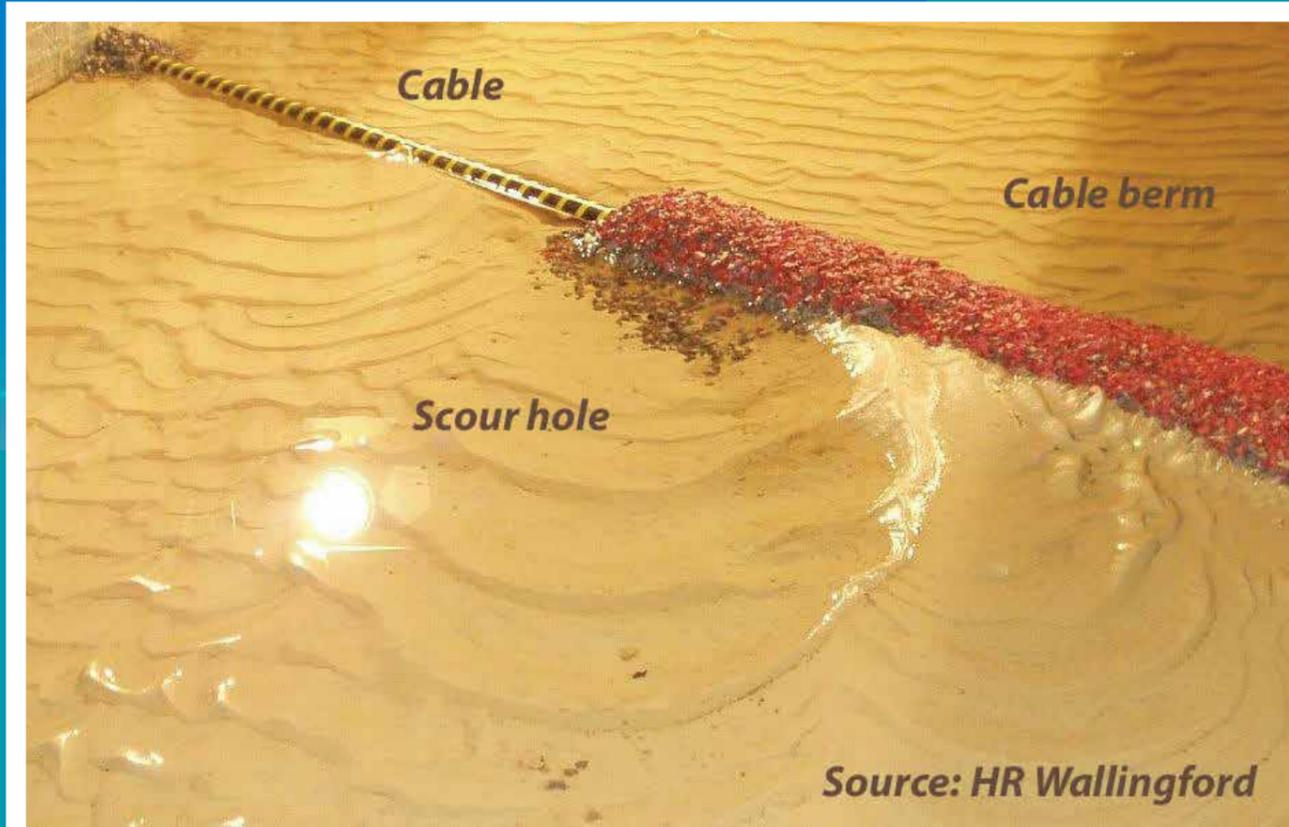
RENEWABLE ENERGY SECTOR

The use of RotaBolt measurement technology is growing across renewable energy. The offshore wind sector is increasingly turning to the benefits of the technology on both turbines and foundational structures, and in wave and tidal power RotaBolts are currently being piloted and assessed on a number of projects.

James Walker RotaBolt



Cable Protection in Offshore Energy Installations



HR Wallingford has undertaken a lengthy research programme investigating the impact of scour in marine sediments around the foundations & cabling associated with marine renewable energy installations.

THE NEED FOR SUBMARINE CABLE PROTECTION

Submarine cables are a vital part of our infrastructure, allowing power captured offshore to be brought onshore and connected to the national grid. Our continued exploitation of marine resources, has led to specific needs for scour hazard assessment relating to the associated foundation structures and cabling necessary for in-field transmission and power export.

There is a requirement to protect cables in coastal waters to ensure their stability and integrity and the preference is to bury the cables where possible. However depending on seabed soil conditions this is not always possible and other protective measures are likely to be required such as mattress or rock protection.

CAREFUL CONSIDERATION

A poorly considered solution may be as damaging to the cable in the longer term as not placing any protection. By its very nature the scour protection design will be liable to induce secondary scouring as it represents an increase in seabed elevation relative to background levels as well as a change in bed roughness, thus inducing a change in the seabed boundary layer flows and a corresponding increase in turbulence.

In morphologically dynamic environments this can be further exacerbated by general changes in the seabed level and may be associated with the movement of bedforms (such as sand waves) through the area.

CHALLENGES

A number of challenges remain if we are to deliver efficient and effective solutions to reduce the risk to cables' stability and integrity. Scour mitigation measures still lack any full understanding of comparative performance offshore and there is a need to develop better engineering models to provide reliable predictions of scour.

WORKING TOWARDS A SOLUTION

HR Wallingford is working to achieve this through combining field data with laboratory and numerical data. Further, not only do we require better tools, we require a better framework to capture the information and greater openness to allow the data to be shared across the community.



Dr John Harris
& Professor Richard Whitehouse
HR Wallingford Ltd

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Pipeline & Cable Protection Specialist

A world leader in subsea pipeline and cable protection, Pipeshield is well known and has a highly reputable brand in the offshore oil and gas arena and are leading source of knowledge on cable protection and scour prevention and protection within renewables.

GLOBAL PRESENCE

Headquartered in Lowestoft, the company maintains manufacturing bases in England and Scotland and has established a permanent manufacturing arrangement in South East Asia and production experience in the Middle East, Malaysia, Canada and South Africa.

BESPOKE SOLUTIONS

Pipeshield has been working with some of the biggest companies in this arena to develop bespoke solutions to one of the most prolific problems renewable energy has to resolve subsea.

The company has provided mattresses on the SWRDA Wave Hub project as well as a number of windfarm projects and provided a variety of protection schemes in often very onerous conditions for the offshore oil and gas industry.

CONCRETE MATTRESSES

Concrete mattresses provide scour prevention, stabilisation and protection. The flexible nature of the block form ensures that the seabed and cable contours are closely followed. In the event of any localised scouring around the edge of the mattress then blocks will settle into the hole to prevent undercutting.

FROND SYSTEM

To enhance the scour protection a frond system can be fitted to the mattresses prior to deployment and then activated post installation. In the right conditions the fronds will attract up to 1m of sediment over and around the mattress providing enhanced stability and impact protection.

NEW STABILISATION SYSTEM

The company has also recently developed a new stabilisation system - rock matting (patent application filed). These are rectangular shaped gabion systems using reinforced nylon netting and are installed using a deployment frame and perform in a similar manner to concrete mattresses.

ACCREDITATION

Pipeshield is approved to ISO 9001:2008, 14001:2004, ISO 18001, and is a supplier member to FPAL and has achieved the VERIFY status for its quality systems

CASE STUDY – WAVE HUB PROJECT

The SW Regional Development Agency (SWRDA) commissioned JP Kenny and CTC Marine to design and install an export cable from a central Hub north of St Ives to St Ives Bay, a route of 24.5 km. The hub was connected to a number of generating devices as a trial to evaluate reliability.

From a maximum depth of 60m to the shore the cable require additional protection to the proposed rock dump. Pipeshield designed and manufactured heavy density concrete mattresses to enhance the stability.

These mattresses incorporated the patented Nose and Notch edge blocks on all four sides to prevent failure of the mattresses by edge lift. Mattresses were placed at defined intervals along the cable route with the higher density units placed in the shallower regions where more onerous on bottom conditions exist.

Pipeshield International

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Frank Fortune: Wave and Tidal Development Director, Renewable Energy
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The Meygen Project

As world-class providers of innovative technology connecting the global offshore energy industry, JDR have become a household name within the renewables sector.

They provide world leading subsea thermoplastic and steel tube production umbilicals and medium to high voltage subsea power cables, the latter of which we wish to concentrate primarily within renewable tidal projects, one in particular, in the paragraphs to come.

TENACITY

It is heartening to hear that after hours, in this case years, of preparatory work and minutiae detail a new award to JDR has finally come to fruition. Congratulations are order of the day!

JDR have successfully been awarded the contract for the Meygen Atlantis Project. I was fortunate to speak with not just one but two alumni who have been involved with this exciting wave and tidal venture – James Young, Engineering Director and Brad Rabone, Sales Manager.

STROMA

The successful leasing round granted by The Crown Estate on the Pentland Firth is situated in the area between Stroma (aptnly named as the Norse definition is 'Island in the Stream' and inhabited by particularly quiet neighbours, namely seals, birds and sheep) and the North East tip of the Scottish Mainland (known as InnerSound) an area of 3.5 km² of fast flowing tidal water.

It is here the proposed wave turbines will be installed, in a series of 4 phases in total. The long term aim is to generate up to 400 megawatts (MW) of electricity by harnessing tidal currents, sufficient to serve around 400,000 homes by 2020.

Phase 1A (confirmed business) will consist of 80 - 84 turbines, with the initial array to be deployed in the first two years. Brad offered that Adam Wells (JDR Commercial Sales Manager) has been liaising over the last few years supporting the client on this project and will continue to do so in the future 6 years and 3 remaining phases. JDR are responsible for designing and manufacturing the cabling for on and offshore, offshore to the sub-station to the grid at Gills Bay and operations at Scrabster Harbour.

INVALUABLE EXPERIENCE

With such a new and evolving and ambitious sector James continued that the company and the team's previous experience has been drawn from the Meygen Project and goes on to describe the Beatrice Project; The Beatrice Windfarm cable project was installed during 2006-2007. JDR's experience with MV cabling goes back to 2001.

The company was contracted to design, manufacture and test two composite inter-array subsea power cables. James continued "Beatrice was one of the most complex renewable energy cables we have worked on, involving 3 phase power, emergency power cores and 2 optical cables all combined within the main composite cable. Special armouring



James Young

was designed to withstand the harsh conditions in the deepwater to protect the essential cables, however on the back of the Beatrice Demonstrator this experience has proved invaluable to make similarities to the Meygen Project."

TECHNICAL SPECIFICATION

Having concentrated generally on the project now it is time for some technical specifications and the juicy bits regarding the Meygen Project.

JDR will provide 2.5km of custom-designed, double and quad armoured cables manufactured at their plant in Hartlepool. The extra armouring is an essential part of the cable design where it will protect the cable from extreme currents and make it more stable. The armouring is alternated between double and quad every 700 metres – this innovation and expertise benefits the client not only in receiving a quality product but also minimising the cost for the client as it is in sections and not the whole length.

MEETING OF THE MINDS – CLUSTER HUB

James goes on to say "Innovation and technology development at JDR has now been centralised with the opening last month of the state-of-the-art JDR Cambridge Research and Development Technology Centre, whereupon experienced engineers and graduates develop product concepts and collaborate with other

technology based companies to ensure subsea energy projects are constantly striving for the highest standard possible and remain at the forefront of developments in this sector."

ACCOLADES

It would be rude of me, nay almost dismissive if I omitted to mention some very significant and well deserved awards presented to the company. The very prestigious Queens Award in 2010 and 2014 for continued outstanding achievement and innovation, not to mention the 2013 EEF Business Growth Award and Future Manufacturing Awards for the South East Region.

In addition to the regional EEF awards the company was also national runner up in the national business growth category.

FACTOID

An interesting truism if you are holidaying in Cornwall, St Ives is that there is another world-first that JDR may boast – under the beach from the Bristol Channel there is a 25 kilometre long 6 core 33 kV cable submerged...not many people know that!

AND ANOTHER...

The horizontal flow of seawater is 832 times denser than air therefore a 5 knot ocean current produces more kinetic energy than 350km/h wind. High energy density therefore a smaller device is required.

IN A NUTSHELL

After speaking to these two luminary gentleman it seems there are not enough column inches to make a more concentrated account, however this is just a 'Snap Shot' into the innovative and far

reaching technological breakthroughs this company have achieved and are continuing to achieve. We look forward to catching up with them in future issues to hear the progress of this and other ground breaking ventures.

Interview by Fliss Chaffer
Wave & Tidal Energy Network

JDR

[Click to view more info](#)

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Scottish Renewables' Marine Event

23RD & 24TH SEPTEMBER

Winston Churchill once famously said that *"Of all the small nations of this earth, perhaps only the ancient Greeks surpass the Scots in their contribution to mankind."*

PROUD HISTORY, BRIGHT FUTURE

Scotland has a long and proud history of innovation that has transformed the modern world. This small country has brought the world the steam engine, the bicycle, the telephone, the television, penicillin, radar and insulin – the list could go on.

Now, as the world searches for new, greener, more sustainable ways of producing energy, it once again turns to Scotland for the answers.

Scottish Renewables' Marine Conference, Exhibition & Dinner, to be held in Inverness on 23rd and 24th September will showcase the cutting-edge wave and tidal energy technologies and expertise being developed here in Scotland, while tackling the tough issues facing the sector in 2014.

EXCITING DEVELOPMENTS

In the twelve months, since the industry last met in Inverness, we have seen some exciting developments within the sector.

The Crown Estate recently announced a host of new wave and tidal site leases around the UK, including four here in Scotland, indicating the appetite for new developments remains strong. Excitingly, two of these sites will be taken forward in partnership with community trusts, further enabling communities to take their energy future into their own hands.

WORLD'S FIRST COMMUNITY OWNED TIDAL TURBINE

Continuing on the community theme, the world's first community owned tidal turbine – in North Yell, Shetland – started exporting electricity. The turbine will power up to 30 homes and a locally-owned ice plant at Cullivoe Harbour Industrial Estate, was described as *"a tremendous moment for North Yell"* by North Yell Development Council Chairman Robert Henderson.

NOVA SCOTIA PROJECT

We've also seen home-grown Scottish company Nautricity sign an agreement to develop a 500kW project in Nova Scotia – yet another example of the huge export opportunities open Scotland if we continue to build on our world-leading position.

POTENTIAL

Despite the exciting developments outlined above, building on that position as a world leader and securing Scotland's place at the forefront of a global industry which has the potential to be worth over £70 billion to the UK economy by 2050 won't be easy.

How to do so, indeed, will be one of the many questions industry experts will address during Scottish Renewables' conference in Inverness.

CHALLENGES

Scotland's marine energy sector faces some really tough issues. Driven by a diverse set of challenges including electricity market reform and access to grid, the sector has had to readjust its pre-2020 deployment level expectations, posing serious questions about the pace and scale of future wave and tidal energy development in Scotland.

So just how far away from the commercialisation of wave and tidal energy are we?

Do wave and tidal energy technologies now need distinct policy solutions? How can we create a market beyond 2020? Has the time come to radically overhaul the way the marine energy sector is funded?

UNPARALLELED OPPORTUNITY

The September event is an unparalleled opportunity to discuss these critical questions with Scotland's key industry players.

After an address by Scottish Energy Minister Fergus Ewing, sessions will be chaired by internationally-renowned figures including Dr Bernie Bulkin – formerly BP's Chief Scientist – and Stephen Gethins, Convenor of the Advisory Board at independent think-tank Scottish Global Forum and a former special advisor on energy and climate change to Scotland's First Minister.

Mary McAllan, Director of Energy and Climate Change at the Scottish Government, will debate the future of marine power with Lindsay McQuade, Policy and Innovation Director at ScottishPower Renewables – one of the country's largest renewables players – and Martin McAdam of wave power innovators Aquamarine Power in the final session of the two-day event, to be held at the Eden Court arts venue in the city.

Lindsay Leask
Senior Policy Manager
Scottish Renewables

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"Of all the small nations of this earth, perhaps only the ancient Greeks surpass the Scots in their contribution to mankind."

Winston Churchill

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INNOVATION BUILT ON EXPERIENCE

THE QUEEN'S AWARDS FOR ENTERPRISE INTERNATIONAL TRADE 2012

TRAINING THE NEXT GENERATION OF RENEWABLE ENERGY SPECIALISTS

HR Wallingford run a series of summer schools and other training courses throughout the year to help the next generation of engineers and scientists understand the complexities and challenges faced in the marine environment.

TOPICS

The open programme of events covers topics in water and marine hydraulics, engineering and environmental management.

The training courses give engineers and scientists in the wave and tidal industry an exceptional opportunity to improve their understanding of hydrodynamic modelling and how to combine this with other tools to enable successful project development.

REGULAR FIXTURE

A regular fixture in the training calendar is the ten day IMarEST accredited IDCORE summer school which focuses on the offshore renewable energy industry.

It covers site selection, environmental assessments, wave and flow modelling, maritime engineering, wave forces and marine scour.

DELIVERED BY EXPERTS

These renewable energy focused training courses are delivered by the organisations' internationally recognised experts, who share their knowledge based on extensive practical experience.

THEORY AND PRACTICE

The programme combines background theory with practical examples and in some cases, a chance to interact with state-of-the-art physical modelling and ship simulation suite facilities at their site in Oxfordshire.

SUMMER 2014

A second summer school was held recently on hydrodynamic modelling using the open source TELEMAC software, combining theory and practical examples.

This was the first time the individual courses had been combined in a one-week summer school, though they had been held previously as separate stand-alone courses.

Students have the option to sign up for the whole five day course, or pick and choose the days they are most interested in.

AUTUMN SCHEDULE

Other maritime courses scheduled this autumn include marine scour, wave forces, wave overtopping and an introduction to wave modelling using SWAN.

HR Wallingford

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Overcoming Challenging Waters off the Stonehaven Coastline

Stonehaven is once again set to become the offshore renewable, as well as the oil & gas industry's top location for fast rescue craft training

FAST RESCUE CRAFT SET TO ARRIVE AND OPEN DAY PLANNED

The arrival in June, at Stonehaven Harbour, Scotland, of two new emergency fast rescue craft, signals the imminent restart of a wide range of Maersk Training programmes at the newly opened Maritime Training Academy, which is owned by their Aberdeen-based partners, Survival Craft Inspectorate (SCI).

10 YEAR AGREEMENT

The two companies have entered into a ten year agreement, aimed at establishing the facility as a world-leader in the training of Boatmen and Coxswains in the use of Fast Rescue Craft.

INVESTMENT

This is a significant investment by Maersk Training, coupled with the investment made in the recruitment of additional instructors for the facility. An open day to showcase the academy and to learn more about the courses on offer will be held in late September 2014.

STERN TEST

Stuart Cameron, UK Managing Director for Maersk Training, a global training company involved in oil and gas, maritime and renewable training, said: *"Companies in the sector can be assured the academy offers first rate training facilities and more critically, that the challenging waters of the North Sea around the Stonehaven coastline - with its coves and inlets - provides the sternest test of any facility in the UK for fast rescue training."*

INCREASING DEMAND

"The industry has been aware for some time of our plans and there is a tremendous level of interest already generated. Indeed, we believe that in the first year a high number of delegates will be trained at the facility with demand increasing as new vessels come online by 2015 and grow from there on."

LEADING PROVIDER IN OPITO RELATED TRAINING

Maersk Training, as a leading provider of OPITO related training ranging from survival to firefighting to boat training, will offer a wide range of courses from the Academy including Fast Rescue Craft Boatman, Fast Rescue Craft Coxswain, Daughter Craft Coxswain, Twin Fall Lifeboat Coxswain and technical training associated medical courses ITSO and AMA, alongside technical training.

EMERGENCY RESPONSE FACILITY LOGISTICS

With all of its emergency response facilities located within a ten to fifteen minute drive of each other, Maersk Training is the only training provider in Aberdeen able to offer these courses in such close proximity.

DECEMBER 2013 STORM

A rescue training centre and voluntary lifeboat had existed at Stonehaven for over 30 years being run by the charity the Maritime Rescue Institute (MRI). However, in December 2013 its fleet of boats and headquarters sustained extensive damage during the high winds, rain and floods which battered the town and it was forced to close.

SURVIVAL CRAFT INSTITUTE (SCI)

With tremendous support from Stonehaven Harbour Board and Aberdeenshire Council, the SCI has invested a substantial six figure sum in building the new facility and equipment, so as to train its own customers in its emergency marine evacuation systems.

The Stonehaven site includes the main building, offices, classrooms and workshop on the harbour front and an additional building which will be used as a training room.

CONFIDENT RETURN

Stuart added: *"The industry will be well aware that prior to the storm damage, Maersk had successfully operated training courses from the Maritime Rescue Institute and the loss of the facility was a great blow to the town."*

"With all the fresh investment that has now taken place we are returning with great confidence and vigour in the knowledge that out of that sad period we have seen the development of a world class facility for the renewable and oil & gas sector and one that the community of Stonehaven can be extremely proud of."



EXPERIENCE

SCI has more than 22 year experience in the manufacture, supply and maintenance of lifeboats, davits, liferafts and fast rescue craft and the Academy – which complements SCI's established training school at Findon – will enhance the skills and competence of those personnel who use, install and service lifesaving equipment.

Maersk Training

[Click to view more info](#)

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Fifty Years Corrosion Protection For Wave and Tidal Energy Structures

CAN STEEL DESIGNED AND FABRICATED FOR WAVE AND TIDAL ENERGY STRUCTURES BE PROTECTED FROM THE RAVAGES OF CORROSION FOR FIFTY YEARS?

LONG TERM SOLUTIONS

In an age when designers, operators and asset managers are looking for long term cost effective resolutions to the problems of corrosion to steel and budgets are tight, long term corrosion protection must be the starting point.

TRADITIONAL PAINT SYSTEMS

Traditional high performance paint systems used in the marine industry will have limited maintenance free performance life under the harsh operating conditions of wave and tidal energy structures.

Such structures, once installed, would be very difficult, if not impossible, to revisit and certainly traditional maintenance painting programmes are not feasible.

RESIN TECHNOLOGY

Based on thirty years known resin technology and performance the answer could be yes, providing specifications are right and the preparation and application is carried out to the required standards.

The resin technology is based on solvent free polyurethane and there is a product that does have over thirty year's maintenance free track record.

HISTORICAL EVIDENCE

Acothane, a solvent free pure polyurethane, was formulated and developed in the late 70's and early 80's and had its first industrial applications in 1980. Following testing and site trials it was registered by ACO Coatings UK Ltd in 1984.

During the 80's and early 90's applications for offshore North Sea operators included splash zones on station, conductor tubes and risers, sub sea pipelines and housings and anti-slip deck coatings.



There is now evidence of applications carried out during this period still showing excellent maintenance free performance for over thirty years with a maintenance free life expectancy of up to and perhaps over fifty years.

Pipelines including subsea and sea water transmission pipelines have received effective corrosion protection to internal and external surfaces for over twenty five years.

DETAILED EVIDENCE...

- Steel barrage structure was coated in the UK and shipped to the Far East in 1986 with no transit or installation damage to the coating and is still affording full corrosion protection in saline water immersion conditions

- Sea water pipelines and condenser boxes in UK power stations have been operational since 1984 with excellent corrosion protection
- During decommissioning of one UK power station, the condenser boxes were found to be in perfect condition after twenty years sea water immersion service
- Marine structures including jetty structures and marine piles have proven corrosion free performance for over twenty five years with the added advantage of much reduced marine growth adhesion which can be easily removed by high pressure water jetting without damage to the coating

- During the period 1984 to 1994 over 200,000 square metres of steel bridge structures were coated in the UK following an extensive test programme run by British Steel Swinden Technology Centre
- During the same period significant work was carried out in the UK water industry where Acothane was applied to surge vessels, process vessels and GAC filter vessels, pipelines and sewage digesters, waste channels and bund areas

SURVEY FINDINGS

Surveys carried out on a number of structures after twenty to twenty five years are positive and a further twenty to twenty five years corrosion protection has been forecast.

Once applied to a correctly prepared surface it is extremely difficult if not impossible to remove Acothane from the steel surface and various grit blasting trials have proved this over many years.

WATERPROOF MEMBRANE

With high adhesion values to abrasive blast cleaned steel and mechanically prepared surfaces at a film thickness of over 750 microns Acothane provides a waterproof membrane so future corrosion problems associated with oxygen and water permeability are eliminated.

Film thickness of up to and over 2mm can be applied in a single wet on wet spray application and while there is no limitation to high film build a final applied thickness of 1mm to 2mm will accommodate all water immersion and impact and abrasion conditions encountered in marine applications.

SURFACE TOLERANT

It is also surface tolerant and will accommodate a degree of post blast gingering and tightly adherent corrosion pockets.

Curing is rapid at all temperatures and hand applied grades for stripe coating can be over coated after two hours. The spray applied coating is hard dry in four hours and will tolerate water contamination as soon as surface set has taken place.

Should it be necessary to revisit and over coat certain areas this can be done within twenty four hours without any re-preparation and at any time after this by abrading the surface of the cured coating with coarse mineral pads or flash blasting and adhesion of new product to aged product is excellent.

NEW STRUCTURE SAVINGS

For new structures significant time savings can be made on in-house applications over conventional paint systems as Acothane can be spray applied in a single wet on wet application to the full specified thickness and will be hard enough to handle after four hours.

Impact and abrasion resistance reduces or eliminates the requirement for onsite touch up and repairs which if necessary can be carried out with hand grades of the same formulation.

PROVEN MAINTENANCE FREE PERFORMANCE

With over thirty years proven maintenance free performance in a wide variety of aggressive environments there is a system which may accommodate the requirement for fifty years corrosion protection providing the specification is right going in and the preparation and application is carried out by competent partner applicators who will give due regard to all the necessary standards to achieve the long performance life.

Ray Sams
Technical Consultant
Spencer Coatings/ACOTHANE

[Click to view more info](#)

WORLD LEADERS

Scotland is widely recognised as the world leader in marine renewable energy development. This is largely a product of...

Its high quality resource, estimated to be 25% of Europe's tidal energy potential and...

- 10% of its wave potential (The Scottish Government, 2011)
- The Scottish Government's commitment to the sector
- Its unparalleled innovation and testing infrastructure

ACADEMIC EXCELLENCE

The University of Edinburgh has been at the forefront of marine energy research since the pioneering work of Professor Stephen Salter in the 1970's. Today, the Institute for Energy Systems at the University continues this tradition with research ranging from resource assessment and prediction, energy storage techniques and distribution network management to converter design, optimisation and control. The University also operates the UK Centre for Marine Energy research and is home to the FloWave Ocean Energy Research Facility; a state-of-the-art marine device testing facility developed to serve academic and industrial research communities.

By maintaining a clear industry focus, the Institute for Energy Systems has enabled significant commercial development in marine renewables, including world-class wave making and tank building by Edinburgh Designs Limited, the development and application of Digital Displacement TM technology by Artemis Intelligent Power Limited and inspiration for the development of the Pelamis wave energy converter by Dr Richard Yemm, a former PhD student of the University and CEO of Pelamis Wave Power.

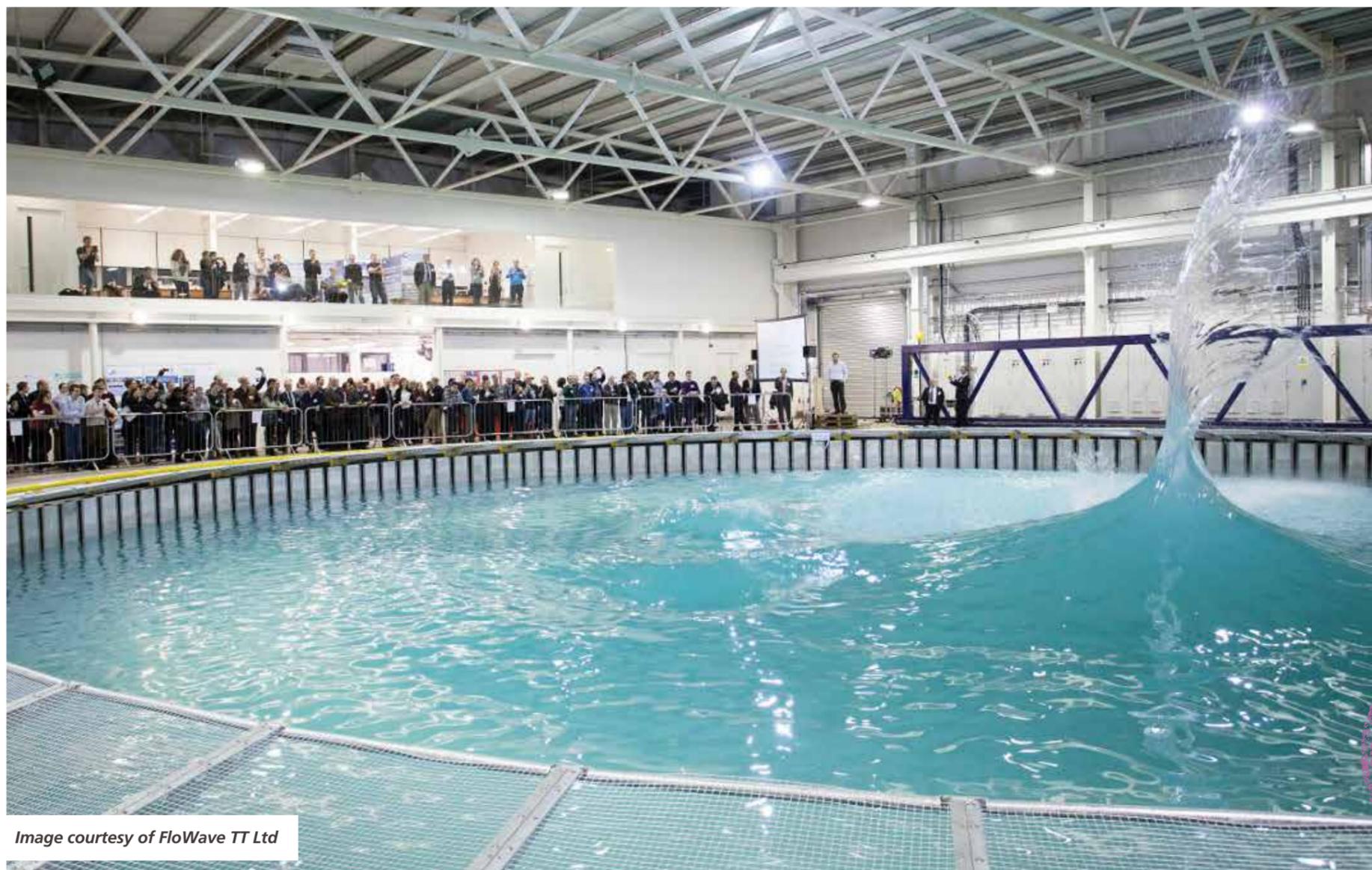


Image courtesy of FloWave TT Ltd

SUCCEEDING THROUGH COLLABORATION

To ensure that future research at the Institute for Energy Systems remains centred on the needs of the industry, it has adopted a number of initiatives to encourage collaboration with organisations across the sector. One such initiative is to offer students on the Sustainable Energy Systems MSc programme the opportunity to undertake an internship with a sponsoring company/institution as part of their dissertation project.

INDUSTRIAL PARTNER

This year, the Institute for Energy Systems worked with the JBA Trust charity to deliver two marine renewable energy dissertation projects. JBA Trust supports research, education and training in environmental risks and resources and facilitates collaboration between academia, NGOs and industry, including the JBA Group of companies.

The two dissertation projects investigated how weather and sea-state data; and innovative strategic planning tools can be used to help reduce the commercial and health and safety risks associated with operating on energy projects in the harsh marine environment. The students were supervised by senior staff from JBA Consulting's Marine and Coastal Risk Management group. This collaborative process allowed the students to gain valuable experience of industry and applied research. They also benefited from the extensive numerical modelling and marine forecasting expertise of JBA Consulting staff and their industry partners.

KNOWLEDGE SHARING - AUGUST 2014

Commenting on the partnership with JBA Trust and JBA Consulting, Deputy Head of the Institute for Energy Systems, Professor Gareth Harrison said *"In order for Scotland to continue leading the deployment of wave and tidal arrays, collaboration between industry and academia is essential. Innovation and best practice must be shared widely to support continued development of the sector. Through its work with the JBA Trust and JBA Consulting, the University of Edinburgh is well placed to facilitate this sort of collaboration over the months and years to come."*

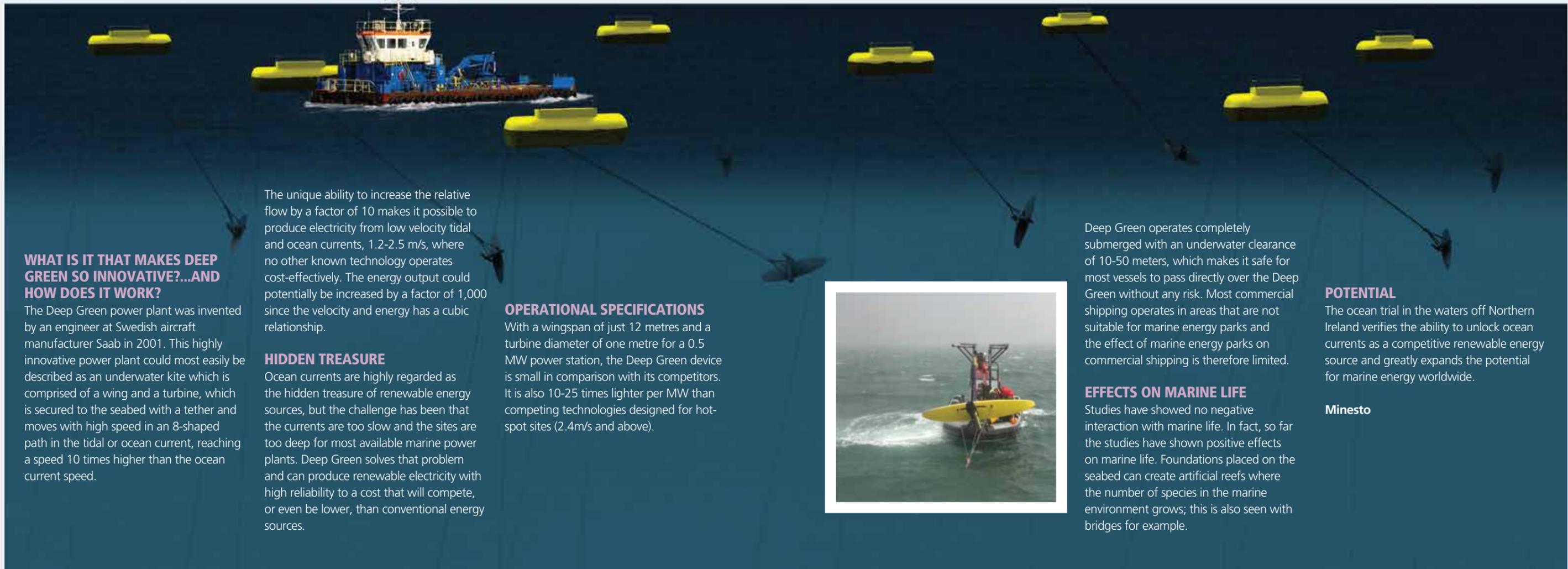
JBA Consulting

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A Step-change Innovation in Marine Energy Technology

The Deep Green marine power plant, which has attracted much attention lately from the global marine energy industry and media, is now producing electricity in Northern Ireland proving viability for a huge tidal and ocean current power market. It is the only known marine power plant designed to produce electricity from low velocity tidal and ocean currents.



WHAT IS IT THAT MAKES DEEP GREEN SO INNOVATIVE?...AND HOW DOES IT WORK?

The Deep Green power plant was invented by an engineer at Swedish aircraft manufacturer Saab in 2001. This highly innovative power plant could most easily be described as an underwater kite which is comprised of a wing and a turbine, which is secured to the seabed with a tether and moves with high speed in an 8-shaped path in the tidal or ocean current, reaching a speed 10 times higher than the ocean current speed.

The unique ability to increase the relative flow by a factor of 10 makes it possible to produce electricity from low velocity tidal and ocean currents, 1.2-2.5 m/s, where no other known technology operates cost-effectively. The energy output could potentially be increased by a factor of 1,000 since the velocity and energy has a cubic relationship.

HIDDEN TREASURE

Ocean currents are highly regarded as the hidden treasure of renewable energy sources, but the challenge has been that the currents are too slow and the sites are too deep for most available marine power plants. Deep Green solves that problem and can produce renewable electricity with high reliability to a cost that will compete, or even be lower, than conventional energy sources.

OPERATIONAL SPECIFICATIONS

With a wingspan of just 12 metres and a turbine diameter of one metre for a 0.5 MW power station, the Deep Green device is small in comparison with its competitors. It is also 10-25 times lighter per MW than competing technologies designed for hot-spot sites (2.4m/s and above).



Deep Green operates completely submerged with an underwater clearance of 10-50 meters, which makes it safe for most vessels to pass directly over the Deep Green without any risk. Most commercial shipping operates in areas that are not suitable for marine energy parks and the effect of marine energy parks on commercial shipping is therefore limited.

EFFECTS ON MARINE LIFE

Studies have showed no negative interaction with marine life. In fact, so far the studies have shown positive effects on marine life. Foundations placed on the seabed can create artificial reefs where the number of species in the marine environment grows; this is also seen with bridges for example.

POTENTIAL

The ocean trial in the waters off Northern Ireland verifies the ability to unlock ocean currents as a competitive renewable energy source and greatly expands the potential for marine energy worldwide.

Minesto

CAPRICORN MARINE TURBINE

RENEWABLE DEVICES MARINE LTD IS PROUD TO ANNOUNCE THE DEVELOPMENT OF THE CAPRICORN MARINE TURBINE, THE WORLD'S MOST ENVIRONMENTALLY SENSITIVE TIDAL STREAM GENERATOR.

FUNDING

Renewable Devices Marine Ltd (the latest company to emerge from the successful Renewable Devices Group) has already secured a private funding package, as well as securing £100,000 worth of innovation funding from the Scottish Government.

Currently the cost of manufacture, maintenance, short lifespan and environmental impact of marine turbines makes their wide scale deployment un-economic when compared to existing forms of electricity generation.

REDUCING COSTS

The UK Government's Technology Strategy Board has made the reduction of manufacture, installation and operation costs of the next generation of tidal device a highest priority. This invention will reduce the environmental impact, reduce cost of manufacture and increase the lifespan of tidal stream generation.

UNIQUE TECHNOLOGIES

The development of the unique technologies in the Capricorn Marine Turbine are built on a wealth of intellectual property developed by their sister companies.

Building on this exceptional technology, Renewable Devices Marine Ltd has developed a unique tidal stream turbine, the Capricorn Marine Turbine, which has been designed to generate electricity from the high efficiency extraction of energy from tidal marine flows.

The current variant - Capricorn 125 - generates 1.25 MW of clean energy.

CAPRICORN MARINE TURBINE - SPECIFICATIONS

The turbine has a horizontal axis, contra-rotating, twin rotor architecture. Each rotor has three blades, designed to be bi-directional in operation, thus negating the need for a yaw mechanism.

The turbine contains innovations relating to the following areas...

- The innovative Bk97 buoyancy control system allows for extremely simple and low cost deployment of the Capricorn turbine
- Extremely accurate and reliable buoyancy control using the Bk97 system allows the turbine to be floated out to its deployment site
- It provides a very controllable means of sinking the turbine on to its foundations and raising it for maintenance purposes, with minimal sub-sea intervention from divers or underwater vehicles being necessary

NOISE IMPACT

The impact of sub-sea industry on marine life is well documented however the understanding of the effect on navigation by marine mammals is a new field of marine biology. Recent studies have shown that noise at certain low frequency ranges has a negative impact on the navigational abilities marine mammals causing stranding and sometimes resulting in the death of whole pods.

Studies have concluded that a single tidal flow turbine operates below these frequencies however the acoustic emissions from arrays of tidal stream turbines will enter into the spectrum that is known to interfere with the navigation of marine mammals.

In November 2012 SRM Projects Ltd was forced to withdraw its licence application for a turbine array in Blackney Passage, British Columbia due to the acoustic risk to marine mammals. The design of a turbine that can be deployed in sensitive areas will expand the global tidal stream resource benefiting the tidal stream industry as a whole. As the UK currently enjoys the market share of this emerging industry the benefits of this technology to the Scottish and UK economy will be substantial.

COST OF DEPLOYMENT AND MAINTENANCE

Much of the cost of deployment and maintenance of tidal stream turbines concerns the lifting and retrieval of the units. All sub-sea systems, those which are physically attached to foundations (rather than floating devices tethered by chain, rod or cable) are transported using large vessels with the capacity and crainage to lift and deploy turbines in excess of 25 tonnes.

These vessels are expensive and the lifting relies upon favourable weather conditions. The Bk97 buoyancy system allows for the Capricorn Turbine to be towed to site as a barge and then sunk and lifted using small and medium sized vessels. This reduces the cost of maintenance and eliminates the risks associated with lifting at sea.

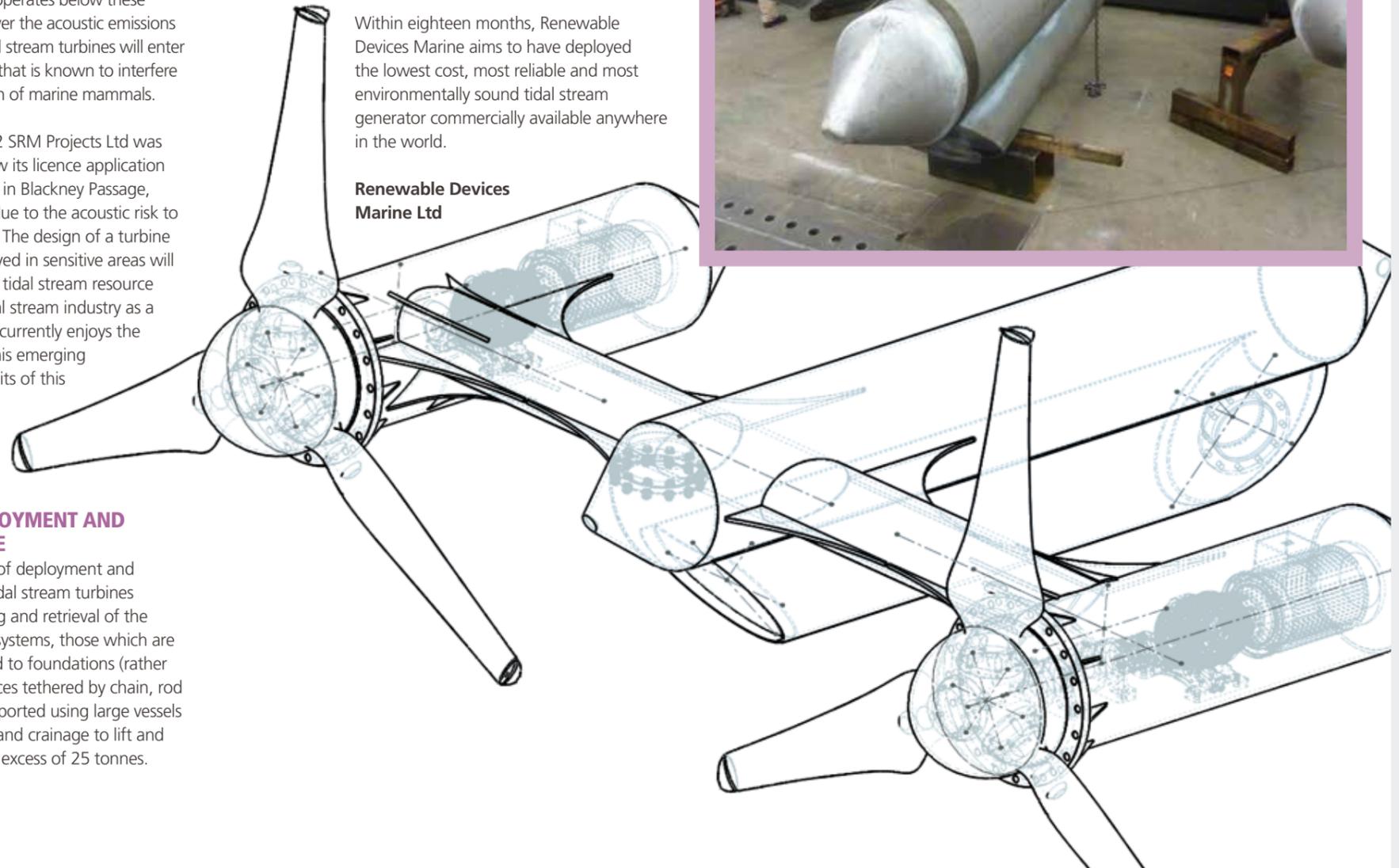
At full buoyancy the turbine floats and can be serviced at the deployment site, or towed to dock for replacement.

LOWEST COST

The Capricorn Marine Turbine is designed to generate environmentally sound energy at the lowest cost per MWh of any other marine generation technology.

Within eighteen months, Renewable Devices Marine aims to have deployed the lowest cost, most reliable and most environmentally sound tidal stream generator commercially available anywhere in the world.

Renewable Devices Marine Ltd



Consent Awarded for the Expansion of Ireland's Subsea Test and Demonstration Facility

The Marine Institute in collaboration with SEAI, the Hydraulics and Maritime Research Centre (UCC) and SmartBay Ireland Ltd have been awarded consent from the Department of Environment, Community and Local Government to install a subsea fibre optic cable from the shore in Spiddal, Co. Galway to an underwater hub that will link to the existing 1/4 scale ocean energy test facility which is located within Galway Bay.

CONNECTIVITY

The sub-sea cable will provide power and data connectivity to the site and will enable ocean energy device developers, researchers, SMEs and MNCs to validate the performance of wave energy converters and new sensors and ICT equipment at various Technical Readiness Levels (TRLs) in a near real time marine environment.

SPECIFICATIONS

The cable termination will contain one fully functional wet mate connector with both electrical and optical circuits and one purely optical wet mate connector.

The Cable End Equipment (CEE) will provide 1 Gb/sec Ethernet, upgradeable to 10 Gb/sec in future expansions. This solution will make the SmartBay research, test and demonstration platform unique in international terms, in that it will provide a level of service for instrument development not offered on any existing cabled observatories.

UNDERWATER RESEARCH NODE

The underwater research node will allow SmartBay to accommodate a large complement of marine sensors including high definition cameras and complex acoustic arrays. The underwater node will be installed on the seabed in water depths of 20m and will be serviced and maintained using divers.

CONTRACT AWARD

Texcel Technologies Plc has been awarded the contract for supplying the CEE and test kit which will allow for rigorous testing of any equipment in a wet-lab environment prior to subsea installation.

Texcel's Commercial Director, Peter Shawyer said *"This is a great opportunity for Texcel to expand the family of Subsea Nodes we produce, whilst working with a dynamic team in a unique project"*.

EXISTING SMARTBAY INFRASTRUCTURE

SmartBay Ireland Ltd is a non-for-profit company which will be responsible for the day-to-day management of Ireland's subsea test and demonstration facility for advanced marine technologies.

Existing SmartBay infrastructure comprises a suite of commercially available technology platforms including a network of buoys equipped with sensors and communication systems. This infrastructure is used for the remote collection of surface and subsurface marine data and for testing and validating new technologies.

UNIQUE OPPORTUNITY

John Breslin, General Manager at SmartBay Ireland Ltd. highlighted that...

"Government support for this facility now provides Ireland with a unique opportunity to develop SmartBay as an International centre of excellence for testing and validating new and innovative ocean energy and marine sensors and ICT products and solutions."

SmartBay Ireland's Chairman Mike Devane said *"We now have a national research, test and demonstration platform for marine technology where the research community can work with small and large enterprises to translate R&D into innovative products, services and solutions for the marine sector to deliver economic impact."*



SmartBay Ireland Ltd

[Click to view more info](#)



10,000 hours

OF GRID CONNECTED OPERATIONS

TWO PELAMIS P2 MACHINES COLLECTIVELY HIT 10,000 TOTAL OPERATIONAL HOURS OF GRID-CONNECTED DEPLOYMENT. THIS MILESTONE WAS ACHIEVED DURING EMEC ENERGY DAY EARLIER THIS YEAR AS SENIOR DELEGATES FROM EUROPEAN COMMISSION VISITED PELAMIS MACHINES OFFSHORE.

BILLIA CROO WAVE TEST SITE

The machines, which are undergoing a progressive test programme at the Billia Croo wave test site, hit the 10,000th hour on Tuesday 3rd June, coinciding with an Ocean Energy Day held by EMEC in partnership with Ocean Energy Europe as part of the EU Sustainable Energy week.

EUROPEAN COMMISSION VISIT

Senior delegates from the European Commission attended a seminar and public exhibition about marine power technology and visited the array of Pelamis machines offshore, while members of the public were invited to visit marine power facilities usually closed to the public, including the Billia Croo substation at the wave test site.

The estimated European annual average wave resource is 167GW, of which Scotland's share has been calculated at around 18%. So while Scotland's strong wave resource, marine expertise, infrastructure and market support present an ideal proving ground for wave power, there is clear potential for commercial scale deployment across European shores and further afield.

ACHIEVEMENTS

Richard Yemm, Pelamis Chief Executive, used the opportunity to highlight the achievements of the Pelamis P2 demonstration programme at EMEC and its importance in the ongoing development of Pelamis technology. *"Every milestone is important in our programme but hitting 10,000 hours on P2 is a big one. We have not only proven that Pelamis technology works, we have also now shown that it works reliably. This progress has been hard won and gives us a unique and solid platform of data and experience to push ahead with optimising the Pelamis system in parallel with ongoing trials."*

"The focus of on-going testing at EMEC through this year has now switched to real at-sea demonstration of major enhancements to system performance through advances in control software, that have as yet only been shown in the laboratory. This, in conjunction with intensive cost engineering work with our supply chain, gives us the potential to reduce our cost of energy quickly and efficiently, at least-cost to the consumer."

EXPERIENCING DIFFERING WAVE CONDITIONS

The two Pelamis machines, one of which is owned by ScottishPower Renewables, are deployed at the Billia Croo site for testing periods in a range of different wave conditions. The P2 machines have experienced over 90% of sea state occurrences for an average year at the Orkney site, including significant wave heights of 5mHs, and individual waves of almost 10m. While installed offshore the machines have been absorbing bursts of power in excess of 2MW and converting this into smooth sustained generation into the national grid, including 30 minute average electrical output of over 280kW.

ONGOING TESTING PROGRAMME

The ongoing testing programme allows the Pelamis team to build on these positive results in order to further optimise the technology and its control systems for commercial deployment.

Neil Kermode, Managing Director of EMEC, said: *"The EMEC test site has been the setting for many technical milestones and world firsts for Pelamis technology and so it's fitting that the 10,000th hour of P2 operations coincides with our Ocean Energy Day. This event is celebrating the successes of the marine power sector and the Pelamis P2 test results are just one indication of what this industry has delivered so far on the path to commercial deployment."*

European Commission representatives in attendance were Andreea Strachinescu (Head of New Energy Technologies, Innovation & Clean Coal, DG Energy), Paul Verhoef (Head of Renewable Energy Sources, DG Research and Innovation) and Mattijs Soede (Policy Officer).

Pelamis

Supporting Renewable Energy in Scotland

SCOTTISH RENEWABLES HAS ALWAYS BEEN AT THE HEART OF THE IMPORTANT DEBATES ON MARINE ENERGY, COMBINING A ROLE SUPPORTING AN INNOVATIVE INDUSTRY WITH THAT OF AN HONEST BROKER WORKING TO ADDRESS THE CHALLENGES IT FACES.



SCOTLAND: THE INNOVATION NATION

Its title, 'Scotland: The Innovation Nation', reflects the country's history in meeting technical and engineering challenges, and our continuing lead in the race to commercialise wave and tidal power generation.

COLLABORATION AND SHARING KNOWLEDGE

Collaboration and knowledge-sharing are crucial to the success of this industry – a point made emphatically by Martin McAdam of Aquamarine Power in this magazine's last edition.

A Global Outlook session at the conference will consider how Scotland can build on its legacy of innovation, capitalise on a growing global market and work collaboratively with other nations to fully realise the potential of marine energy.

Hannah Smith
Policy Officer
Scottish Renewables

WAVE AND TIDAL SECTOR – EUROPEAN MARINE ENERGY CENTRE (EMEC)

The enormous opportunities for the wave and tidal energy sectors were first voiced at Scottish Renewables' inaugural Marine Energy Conference in 2007, where EMEC in Orkney was highlighted as a potential world leader in testing nascent technologies.

Seven years later, EMEC is now filling that global leadership role.

LEADING THE RACE

Scotland has boosted her lead in the race to bring marine energy prototypes to market in August 2014 with the opening of Edinburgh University's £10.5 million FloWave test facility. FloWave – the world's most sophisticated tide and wave simulator – gives marine energy developers the chance to carry out large-scale lab tests of devices and components in Scotland before heading into real-world conditions in Orkney.

POTENTIAL CONTRIBUTION

FloWave's potential contribution to Scotland's marine energy industry will be a talking point for 350 delegates at the eighth Scottish Renewables Marine Energy Conference in Inverness on 23-24 September 2014.

The event is one of a series of Global Excellence conferences sponsored by the Scottish Cities Alliance which will provide a legacy from major events in 2014 including the Commonwealth Games.

SCOTTISH RENEWABLES MARINE CONFERENCE, EXHIBITION & DINNER 2014

WHEN 23 - 24 September 2014
WHERE Inverness

CONTACT www.scottishrenewables.com/events/sr-marine-conference-exhibition-dinner-2014/

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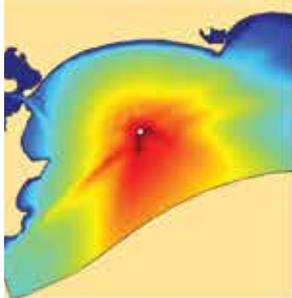


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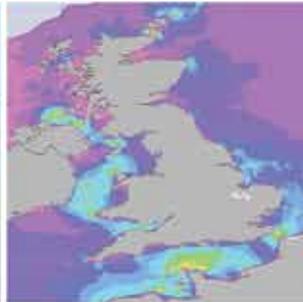
Underwater
noise modelling



Physical
modelling



Ship simulation



SMARTtide



Scour

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