



# Wave & Tidal Energy

NETWORK

COMMUNICATION HUB FOR THE WAVE & TIDAL ENERGY INDUSTRY

## Underwater Acoustics

INDUSTRY VIEWPOINT

**IRELAND  
& SCOTLAND  
PROJECTS**

**SPOTLIGHT ON...**  
**ORKNEY/PENTLAND FIRTH**

# Communication is key

**Welcome to Wave & Tidal Energy Network the very first publication in both printed and online magazine formats which is dedicated solely to the industry and with your help will serve as a communication hub.**

This publication is for the industry and will be led by the industry – we want to play our part in ensuring that this is the best vehicle of communication for all involved in the wave and tidal energy industry.

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

## LEAD ARTICLE – INDUSTRY VIEWPOINT

Martin McCall CEO at Aquamarine starts off our launch edition and the first of our 'Industry Viewpoint' features. If you feel you would like to have the opportunity to contribute to a future viewpoint please feel free to offer your editorial which will be considered for future editions.

## SPOTLIGHT ON SCOTLAND AND IRELAND

It is no surprise that we feature both Scotland and Ireland within two of our features within this launch edition. The areas involved 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.

## ORKNEY AND THE PENTLAND FIRTH

The home of the The Highlands & Islands Enterprise who continually strive to focus on the needs of the renewable energy industry. One of the many highlights within this feature is the vast European Marine Energy Park.

## SCOTLAND AND IRELAND PROJECTS

This features the breadth of projects which are happening in both countries.

## 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 micropage of the featured company or organisation held within our website, so that you can learn much more in all sorts of formats.

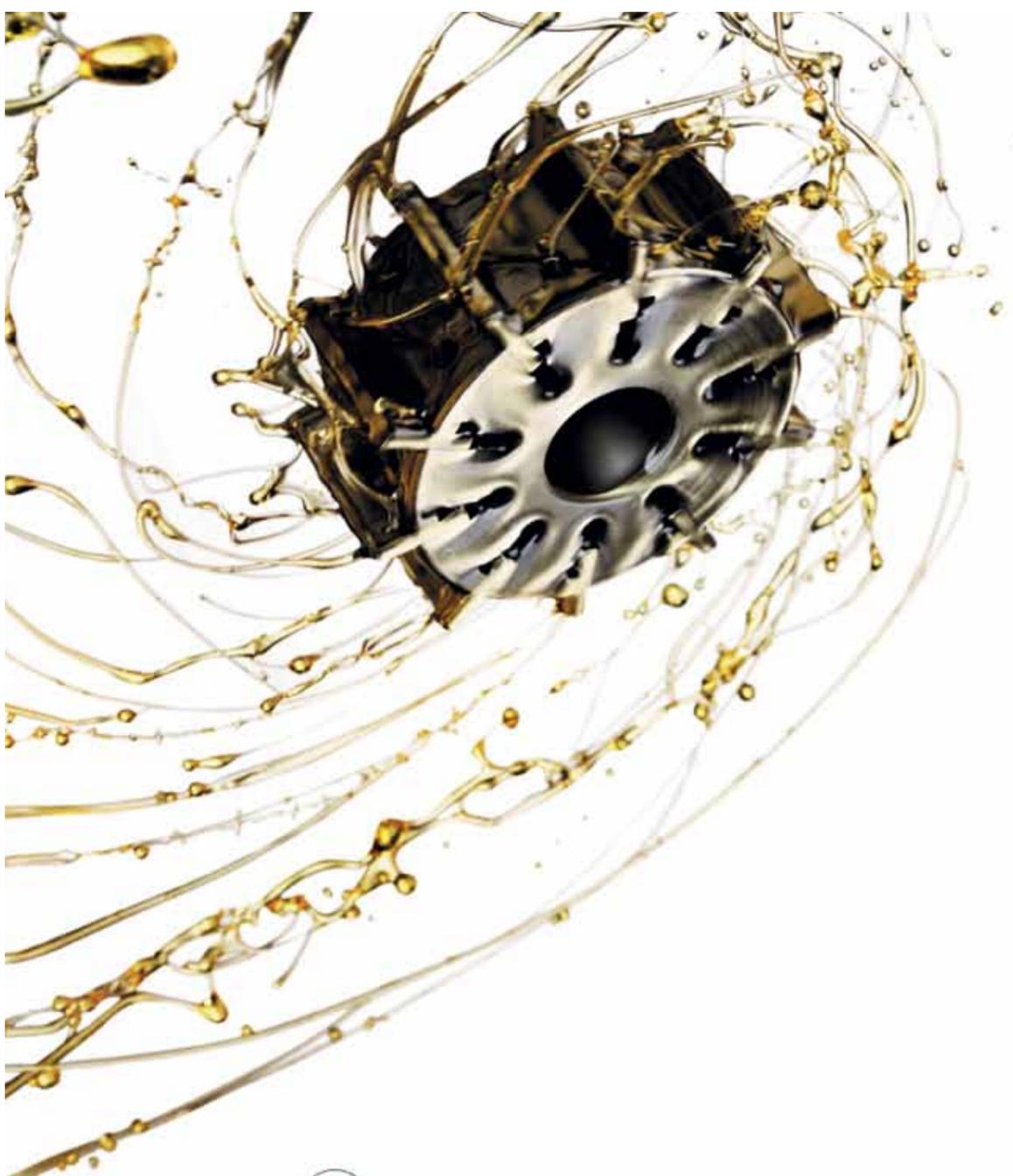
These have already become very popular as they link to both the printed on online magazines in a very interactive way – a great marketing tool for our decision making readership to find out about products and services following the reading of an interesting article.

I look forward to working with you in the weeks and months to come.



*D. McGilvray*

**Duncan McGilvray - Editor  
Wave & Tidal Energy Network**



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The cover image was supplied by the Highlands & Islands Enterprise sponsors of our Spotlight on Orkney and the Pentland Firth.

### SCOTLAND AND IRELAND PROJECTS FEATURE

Both countries would appear to have taken the lead in the industry regarding renewable energy and it should be no surprise that we have focused on the breadth of projects involved.

### FOUNDING PARTNERS

Without the help and support of our 'Founding Partners', with whom we have a very special relationship, we would not have been able to launch this first edition. If you are interested in becoming a founding partner please have a look at the various pages within the magazine regarding the 'Founding Partners' and get in touch as there may still be places available.

**Duncan McGilvray**  
**Editor**  
**Wave & Tidal Energy Network**

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# Industry viewpoint

There are a number of companies which have been working in the industry for some time so we thought we should give our readers the views of one of the leaders in the field – if you would like to get involved and give your views please do not hesitate to get in touch.

## AQUAMARINE'S CEO MARTIN MCADAM EXPLAINS...

Aquamarine Power is just over nine years old and I joined the company almost six years ago. When we started out on this journey I guess we all believed that we would be there by now!

The initial exuberance and excitement at creating a new technology to extract electricity from ocean waves then subsided. It was replaced by a reality that this challenge is bigger, more difficult, more expensive and will take longer than we originally thought.

## PREDICTIONS

At that time we as a company and as an industry, were confidently predicting the first working wave farms in our waters by about now. But as we can see, although the first tidal farms are now on the near horizon, the first successful wave arrays are still a few years off.

## OPPORTUNITY

Untapped ocean waves represent a huge opportunity. This technology will be developed and the world will embrace the technology in the same way as we saw gas and wind being embraced in our energy mix.

We may not be there yet but the UK's wave energy industry is already a tremendous success. In Orkney, one of the most remote communities in Europe, more than 200 people already work in the wave and tidal sector. Aquamarine Power has already spent more than £6 million in the local economy, working alongside more than 40 local firms.

## LONG TERM INVESTMENT

At Aquamarine Power, we employ 50 people in high quality, permanent skilled posts in our office in Edinburgh, our research facility at Queen's University Belfast and our operations base in Orkney. Our business has raised more than £60 million private investment, leveraged by around £12 million of public support and boasts SSE and international power firm ABB as major shareholders.

## PROJECT REALITIES

We have consented the world's first ever wave farm, in Lewis, with the potential to generate hundreds of local jobs and have installed and operated two full scale Oyster machines at the European Marine Energy Centre in Orkney. Our flagship Oyster 800 has produced significant amounts of electrical power and has proved its survivability through three full winters and withstood storms with waves in excess of eight metres.

## INDUSTRY NEEDS

A successful industry requires several mature technologies, a willing customer base and a healthy supply chain. The industry needs to be developed within a policy framework that gives investors confidence to invest in developing the technology, gives customers the confidence to buy the technology and provides an economic return in terms of jobs and community benefits.

The UK and Scotland in particular has given this industry a tremendous start. The grant framework, a feed in tariff under EMR and proposals to further develop the grid are all steps to creating the industry. Some work done but much more to do.

## A BETTER UNDERSTANDING

In the early days of the industry we have been over-optimistic – this optimism was fuelled by a lack of information. Now, as an industry, we are more mature. Today we have much more real data on the ocean environment, the limitations of some of the technologies available to us, the cost and performance of machines, a better understanding of grid and consenting timelines and a realistic view of the finance required. This means all sides of the debate – the public sector, industrial investors and technology developers – have a much more grounded view of how our industry will develop and grow.

## EXPERIENCE

The learning from the past years has provided a much clearer picture of the technology challenge. Experience has shown us that wave machines have to be incredibly robust if they are to survive and operate reliably in our energetic seas. Subsystems and components designed for the oil and gas sector sometimes just do not do the job: cylinder modules fail, accumulators corrode and non-return valves fall apart. Aquamarine Power has shown leadership by discussing openly what has not worked on Oyster.

## COMMUNICATING IDEAS AND EMBRACING/SHARING FAILURES

Up to now industry participants have closely guarded their intellectual property and have hidden their failures for fear of being ridiculed or for fear of frightening investors.

This is a big mistake. We must embrace and share our failures – each failure is a learning opportunity. When speaking of his frustration in getting the incandescent light bulb to work reliably, it was Thomas Edison who said: *"I have not failed, I have just found 1000 ways that won't work."* We must learn, we must design out the failure and we must get on with learning more. The worst thing we can do is waste investor cash on solving problems already solved by others. Investors should cherish those companies that are willing and open to co-operation and collaboration.

## GOVERNMENT SUPPORT

Private sector investment alone cannot fund this industry at this stage and we are very fortunate that both UK and Scottish governments remain committed to the sector. New thinking on how to fund the industry is required and this may include introducing industry-wide technology programmes as well as company-specific grants.

## EXCITING TIMES

These are exciting times for the wave energy sector. Other countries, notably Ireland and Chile, are learning from the 'Scottish model' to put in place their own policies in support of wave energy. New markets, like new technologies, take years to develop – and as long as we stay the course in the UK, we can look forward to substantial global markets for our maturing wave technologies in the years ahead.

Martin McAdam  
CEO  
Aquamarine Power



# WAVE & TIDAL ENERGY NETWORK MAGAZINE

## WE ARE DIFFERENT

Those of you who may also be working in the wind energy industry, will be familiar with our other magazine, Wind Energy Network and know how we operate. For those who are not familiar with Green Energy Publishing, our parent company, this is how we work, which sets us apart from other publications:

Our magazines, both online and in print are here to offer a vital communication tool for the industry – for the entire supply chain. We want you to be proactively involved: It is your magazine for your industry

### UNIQUE MAGAZINE

- The magazine is interactive
- The magazine does not charge for editorial. Ever.
- This is the first printed magazine dedicated 100% to your industry

### ENCOURAGE YOU TO CONTRIBUTE

We actively encourage involvement editorially in the magazine. Editorial is always free to contribute and, importantly, there are no conditions linked to advertising.

We are simply looking for the best and most interesting stories to bring to our readership of senior decision makers in the Wave & Tidal Energy industry.

If you have a story which could be included in one of the features we will be running, or in the News section (Industry Update), please send it to us for inclusion.

In this way we believe our readers appreciate decent relevant editorial content and not simply a book full of adverts.

### INTERACTIVE FEATURES

Throughout the magazine you will see coloured links at the end of features. If you click/scan them you will see additional supporting information which will enhance the article you are reading Green ones will play a video, pink ones will open a micro page full of interesting and relevant information.

### HOW WE ARE FUNDED

we are funded in a very different way to most publications.

#### Funding is by a mix of ...

- Website tools which help the supply chain promote their products and services across all tiers (micro-website pages)
- Sponsorships of various industry editorial features
- Limited advertising

### SUBSCRIPTION

Our readership is by subscription and if any of your colleagues would like to receive a copy, please let us know and we will be glad to include them. Contact us: rosie@greenenergypublishing.co.uk

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## World Firsts for Wave & Tidal Power

**10 years of wave and tidal EIA and consenting:**  
World's first grid connected tidal turbine - consented | World's first tidal array - consented | World's first commercial wave array - consented

**Frank Fortune:** Wave and Tidal Development Director, Renewable Energy  
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royalhaskoningdhv.com

## FORTHCOMING FEATURES



### MAY/JUN 2014 ISSUE 2

EDITORIAL DEADLINE 5TH APRIL

- 1 News & Events - sponsored by Smartbay
- 2 Company Profile – W&TEN founding partner – Exxon Mobil
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## FOUNDING PARTNERS

From an editorial standpoint we need advice and assistance in making sure that the publication is both successful and worthwhile to the industry moving forward and this is a very involved way of ensuring we communicate effectively across the whole industry.

We have a number of 'Founding Partners' who have signed up to support our new publication Wave & Tidal Energy Network. Their role is to help, advise and direct our publication.

In exchange they receive a great package of profiling in both the magazine and website.

There are a couple of spaces remaining – if you would like to get involved please contact Rosie, our Commercial Director on rosie@greenenergypublishing.co.uk Or call on **01765 644224**.

**Duncan McGilvray**  
Editor  
Wave & Tidal Energy Network



Click on the logos to see more information.

# PELAMIS WAVE POWER RIDING ON THE CREST!

Thomas Edison was interviewed by a young reporter whom boldly asked Mr Edison if he felt it would be advisable to just give up now? With a perplexed tone Edison replied “young man, why would I feel like a failure? And why would I ever give up? I now know definitively over 9000 ways that an electric light bulb will not work, success is almost in my grasp!” Shortly after that and over 10,000 attempts Edison invented the light bulb!!! Bear with me on this one...this analogy can be likened certainly to my next interviewee Richard Yemm, Inventor extraordinaire and Chief Executive of Pelamis Wave Power.

As we launch our sister publication Wave & Tidal Energy Network it seems only fitting that we find out more about this innovative company, a 16 year journey which has certainly seen peaks and troughs but with vision and tenacity has proved to be a world first.

I caught up with Richard betwixt conferences to find out more about his story....

## MAN OF THE SEA TO ASPIRING FIGHTER PILOT

Richard believes he has ‘salt water in his veins’ and has always had a close connection with the sea through a lifetime sailing. However, living near RAF Leuchars his calling as a child was to become a fighter pilot, as he watched the Phantom jets flying overhead he dreamt of one day piloting one... and so his journey began.

Guided by his parents to pursue his vocation, he successfully acquired sponsorship from the RAF to attend Edinburgh University to study mechanical engineering, attaining a ‘permanent commission’ in the RAF at the tender age of 17.

## PROFESSOR STEPHEN SALTER

It was in his final year of study having to present his thesis, Richard’s interest in wave power was piqued by Stephen Salter, the 1970s inventor of the Salter’s Duck (also known as the nodding duck or more officially the Edinburgh Duck). The Duck was one of the very first wave energy concepts and had been conceived and developed in response to the 1970’s oil price crisis, but development ceased when North Sea oil opened up and the UK Government turned away from alternative energy sources such as wave power.

Wave energy had returned to being a backwater academic curiosity with little or no commercial interest.... but enter Richard Yemm and his dedicated team!

## EPIPHANY MOMENT

Richard recounts his feeling of utter awe when he opened the door of Salter’s laboratory to be met with a huge swimming pool, model boat and an extraordinary wave simulator – it was one of those life-changing experiences that we could call an ‘epiphany’!

His thirst for knowledge within this field was whetted and he continued his final year testing sailing boat hulls in Salter’s tank to attain a PhD in 1993.



**WIND ENERGY**

Richard completed his degree and for 6 years worked as a self-employed design engineer, including a series of major projects in the emerging wind energy sector, working to solve vibration problems on large turbines. However, wave energy was still on his radar.

In the late 90's the Scottish Government was becoming interested in the power of the waves again and offered a commercial tariff in the sector. This was the signal Yemm had been waiting for to take the sector from a research interest to a commercial opportunity – and 'Pelamis' was born.

**PELAMIS WAVE POWER**

All revenues from increasing work in the wind sector were ploughed back into towards developing the new Pelamis technology. After an intensive period of initial research, Pelamis Wave Power was formally founded in 1998. The company grew and gathered momentum through securing its first major external Venture Capital investment in 2002 - this matched with a dedicated team of colleagues and a generous dose of 'serendipity' along the way set them on the path to deliver a world first!

**EUROPEAN MARINE ENERGY CENTRE**

2003 saw the gearing up of the European Marine Energy Centre for wave and tidal power in Orkney, with unparalleled capabilities and facilities.

Richard says that the Orkney Islands are the ideal location for the centre an open aspect to Atlantic waves in close proximity to Scapa Flow, one of Europe's finest natural harbours. With a long history of making a livelihood from the sea, this development was wholeheartedly welcomed by the entrepreneurial Orkney community.

This testing facility has allowed Pelamis to develop and test prototypes over the last few years. The first of these delivered the World's first power from offshore waves to an onshore grid, a true 'Edison' moment for the whole sector. Since then the technology has been progressively refined and as we speak two Pelamis P2 machines are on test in the turbulent Atlantic seas!

The two machines have produced almost 200MWh of energy so far during testing – as Richard puts it "that's just the beginning". The team is now working towards delivering the first stage of a commercial scale wave array in over the next few years, and through this the birth of a new industry.

**THE FUTURE**

Successful delivery of the first arrays will pave the way for large deployments in the future. The next step is to seek an industrial partner to bring in complementary skills, capacity and resources as the project gathers momentum.

**FACTOID**

I was fascinated to learn the origin behind the naming of the company... Richard explained that in the early days of the company he was interviewed by an eminent Times journalist who visited and was given a demonstration. Within the article the journalist suggested the system should be named Whiplash!

This was not quite the image they were wishing to portray so Richard and his team put their heads together to think of a more appropriate one – something marine biologically suitable: clam? limpet? As the apparatus has the action of a snake Pelamis was born (without the Platuras!).

**3 WORDS**

When asked how Richard would describe himself, determined, innovative and passionate about his industry. I concur and would add to that!

His enthusiasm, foresight and sheer dogged tenacity have and will continue to reap the rewards. I would also add he has modesty in bucket-loads, having been awarded the Saltire Prize Medal recognising his and his team's outstanding contributions to the development of wave/tidal generation, which is almost a nod to Stephen Salter, who was awarded an MBE in 2004. We look forward to following his and the teams successes in future.

**Fliss Chaffer**  
Wave & Tidal Energy Network

**Richard Yemm**  
Pelamis Wave Power



# Spotlight on Orkney & Pentland Firth

We welcome the Highlands and Islands Enterprise as our sponsor of the first spotlight feature in the launch magazine.

Elsewhere within this edition you will find interesting editorial from all parts of the UK (Europe and the world to follow in future editions) regarding the wave and tidal industry however Orkney & Pentland Firth lead the way.

**CALUM DAVIDSON, DIRECTOR OF ENERGY, HIGHLANDS AND ISLANDS ENTERPRISE ADVISES HOW EXCITING 2014 AND BEYOND WILL BE.**

## A PIVOTAL YEAR FOR MARINE ENERGY

2014 will be a pivotal year for the wave and tidal industry.

This is a phrase we have heard before, or something similar – but there is no doubt in my mind that the coming 12 months will be critical in the development of this exciting sector.

## 2013 PROGRESS

2013 saw some quite remarkable progress – 11 devices undergoing testing at the European Marine Energy Centre in Orkney, five tidal devices using the new quayside at Hatston Pier, the world’s first fully consented wave farm in the Western Isles, and the world’s largest consented tidal project in the Pentland Firth.

At the same time, all of the public sector agencies with a stake in the industry have helped put the appropriate policy support in place – capital grants to tidal projects through the UK Marine Energy Array Demonstrator scheme and for wave technologies through the Scottish Marine Energy Commercialisation Fund; further financial support from the Crown Estate and the Renewable Energies Investment Fund; a new leasing round from the Crown Estate and a positive £305 MWh tariff, which we hope will be ring-fenced for the first 100MW of development in the coming years.

## EXCITING BUT CHALLENGING

It is an exciting landscape, but there are considerable challenges ahead, and in 2014 I believe we must tackle the major ones – technology, finance and grid – head on.

With technology, we have begun to see major progress in the tidal sector, with a number of developers beginning to rack up megawatt hours on the meter. This is immensely positive, and gives confidence to the large industrial investors this industry needs. For wave, the picture is less clear. Flagship technologies have shown they can generate power, but reliability is a major hurdle and we need to find ways to help them, and other less mature technologies, design, build and test machines in the most effective way possible.



**FINANCE – PROJECT INVESTMENT**

Finance will be key. On the tidal side, the first MEAD-funded tidal arrays in Wales and Islay must be able to attract significant project investment, and this will rely as much on the long-term signals provided by government as the progress of the technologies themselves. Big investors with deep pockets need confidence there will be a supportive tariff regime not just in the current EMR delivery period, but to 2020 and beyond.



*Calum Davidson,  
Director of Energy,  
Highlands and  
Islands Enterprise*



**FINANCE – TECHNOLOGY DEVELOPMENT**

In parallel, we must continue to support technology development, for both wave and tidal sectors. Building any device which can operate reliably in our wild seas is a costly business. The sheer density of the power source means that machines, by their nature, must be big and robust and any testing programmes requires many millions of investment.

**FINANCE – CAPITAL INVESTMENT**

Persuading private capital to invest significant sums, at risk, is a tough ask, and as a public agency we need to think hard how we can leverage our limited budgets to best help investors and the industry as a whole.

This might involve radical new approaches – perhaps funding industry-wide solutions for power take off systems, mooring and cylinder seals, for example, could help a number of technologies make better progress. And are there ways we can help or persuade our oil and gas industry – a vast, hugely successful global industry headquartered here in Scotland – to become involved? Can we, for instance, help turn our supply chain into partners rather than just suppliers?

**GRID CONNECTIONS**

Thirdly, we need to address the lack of grid connections to our Scottish islands. Again, tremendous progress has been made and we welcome the special support for onshore wind announced by UK Energy Minister Ed Davey, but we still need to ensure that island links are built and that support, not just for transmission charges but for the significant securities and liabilities, is in place.

**EUROPEAN MARINE ENERGY CENTRE (EMEC)**

It is now more than 15 years since the idea of EMEC was formed, and it has been the spark which has catalysed our new industry. EMEC has itself become a local and global success, supporting over 200 jobs in a remote community, and helping build political will and enthusiasm around the world, with test centres in development in potential new markets such as Chile, Japan and Singapore.

**THE TIME IS NOW**

So, it has taken a long time to get to where we are today, and now is the time where real resolve is required. I think the UK has, in the past, had a tendency to lose heart in the face of new industrial challenges and to scale back from sunrise industries just at the point when other nations decide to step in.

The wind industry is one obvious example. We all know that British firms pioneered the early technologies and I can personally recall passing Howden's yard in Glasgow's Scotland Street on my daily route to college and seeing early turbines being built for export to California.

These were exciting times, when the UK had a real technology lead. Other countries, notably Denmark, sensed this potential and put in place a very favourable early tariff and grid regime which made their country a more attractive early market than the UK, and the rest as they say is history.

**REALISING POTENTIAL**

I think we have learned from this, and have clear sight not only of the challenges facing the wave and tidal sector, but of the potential we hold. The next-generation nations, all now keen to build test centres and put supportive policies in place, have had their appetite's whetted by our success and will, with a fair wind, be target markets in the decades ahead.

We have the possibility to shape these new markets, and build an industry on our own terms. It will not, as I said, be easy, but the marine energy industry has, and will continue to have, the unequivocal support of the Scottish Government and its agencies as it continues to develop and grow.

It is this kind of support which has enabled us to get so far, and will catalyse the next exciting phase of our industry's journey.

**Calum Davidson**  
Director of Energy  
Highlands and Islands Enterprise

[Click to view more info](#)

[Click to view video](#)

# The European Marine Energy Centre

Even on an otherwise calm summer's day, the Fall of Warness in Orkney is in constant motion. It surges, boils and swirls, its restlessness the result of seabed topography that squeezes the ocean between the islands of Eday and Muckle Green Holm into a fierce eight-knot tidal race.

## TEST BERTHS

Invisible from the surface are test berths suitable for testing tidal energy generators. Each berth is connected to the national grid via subsea cables and a substation on the nearby island of Eday. This tidal test site is operated by The European Marine Energy Centre (EMEC): the world's leading testing facility for wave and tidal energy converters.

## BILLIA CROO

A similar facility for testing wave energy generators exists at Billia Croo, on the west coast of the Orkney mainland. Open to the full force of the Atlantic Ocean, with waves as high as 19 metres recorded, the test site has some of the highest wave energy potential in Europe.

Spend half an hour rocking and rolling in a boat over the Fall of Warness, or stand onshore at Billia Croo during the full force of a winter storm, and it's blatantly obvious why Orkney was chosen as the location for a marine energy test centre. If devices can operate here, and survive the monumentally harsh conditions, they should work anywhere in the world.

## UNRIVALLED LEVELS OF ACTIVITY

Now, ten years after EMEC was established in a public sector leap of faith involving Highlands and Islands Enterprise, Scottish Enterprise, the Scottish and UK governments, Orkney Islands Council, the European Union and the Carbon Trust, Orkney is witnessing unrivalled levels of marine energy activity, with more devices being tested in the islands than at any other location on the planet.

## ACCREDITED WAVE AND TIDAL TEST CENTRE – A GLOBAL FIRST

Based in the town of Stromness on Orkney's west mainland, EMEC is the only accredited wave and tidal test centre for marine renewable energy in the world, suitable for testing a number of full-scale wave and tidal devices simultaneously while producing electricity to the national grid through the company's infrastructure. Operating to relevant test laboratory standards (ISO17025), the Centre provides independently verified performance reports to its clients.

## EASING THE PATH TO MARKET

In addition to its full-scale test berths, EMEC has worked hard to ease the path to market for marine renewable developers by building two scale test sites.

These facilities allow developers to test smaller scale devices, techniques and components in less challenging conditions than those found at the full-scale test sites, closing the gap between testing in a wave or tidal tank and bringing full scale prototypes to trial in real sea conditions.

## CONSULTANCY AND RESEARCH

Beyond device testing, the 25-strong team at EMEC provide a range of consultancy and research services and are at the forefront in the development of international standards for marine energy.

With their expertise much in demand from emerging test sites around the world, the Centre set up a global ocean energy symposium in 2013 to create a network of real-sea test and demonstration facilities, having already forged alliances with various countries around the world including Canada, China, Japan, Singapore, South Korea, Taiwan and the USA.

Ten years on from EMEC's creation, there's a palpable buzz around the marine energy sector in Orkney, with a sense that significant progress is now, finally, being made with EMEC attracting developers from around the globe to prove what is achievable in some of the harshest marine environments.

## CURRENT PROJECTS

At EMEC's wave test site, Pelamis Wave Power and ScottishPower Renewables continue to test their P2 machines – descendants of the world's first offshore wave energy converter to generate electricity to a national grid back in 2004. Finnish Wello Oy and Edinburgh based Aquamarine Power are also racking up experience in testing their devices in Billia Croo's relentless waves.

At the Fall of Warness, OpenHydro, an Irish tidal developer, became the first to feed tidal energy into the UK grid in 2008, and are now testing their 7th generation turbine at EMEC. French developer Alstom has recently deployed their second generation 1MW turbine at the test site, alongside Austrian/Norwegian developer ANDRITZ Hydro Hammerfest and Orkney-based Scotrenewables who are well underway in testing prototype tidal energy devices since trials began in 2011.

New on the scene is Voith from Germany who are working on installing their tidal turbine in 2014.

## OPPORTUNITIES

Whilst an incredible critical mass of activity is already taking place in and around the EMEC test sites, the Centre is by no means full. Test berths are available at both the smaller scale and full scale test sites, so there are always opportunities for new organisations to join EMEC's testing and research activities – fundamentally 'learning by doing'. Learning which extends from installation methods to electrical connections via marine safety and component testing – for any offshore engineering there is no substitute for real sea experience, and still many solutions to be found.

## EMBRACING THE MARINE ENERGY SECTOR

With four wave and five tidal full-scale devices currently in Orkney there is more marine energy activity here than at any other location on the planet. It's no surprise then to find the entrepreneurially minded and resourceful Orcadian community embracing the marine energy sector, with a host of local support services springing up to support the burgeoning industry. Recent estimates put the number of marine renewables related jobs in the island at 250, in sectors ranging from manufacturing to consultancy.

## INVESTMENT

Significant infrastructure investments have also been made with Orkney Islands Council nearing completion of a major harbours development programme to support marine renewables. The scheme has seen the creation of Scotland's longest deep-water berth at Hatston, near Kirkwall, and the expansion of harbour facilities at Lyness on the island of Hoy. Work is also well underway on a new pier at Copland's Dock in Stromness, aimed squarely at developers using EMEC's Billia Croo wave test site.

Given this unprecedented activity, Orkney truly is the home of marine renewable energy.

## The European Marine Energy Centre



# Demo Demonstration Programme EMEC, Orkney

**THE P2 TEST PROGRAMME INVOLVES THE DEPLOYMENT OF TWO PELAMIS P2 MACHINES AT THE EUROPEAN MARINE ENERGY CENTRE (EMEC) OFF THE WEST COAST OF THE ORKNEY MAINLAND**

The P2 machine is an innovative second generation design of Pelamis wave energy converters. Two P2 machines have been deployed offshore at EMEC's Billia Croo test site and are now being operated and maintained as a wave farm, generating electricity to the grid during installation periods.

## E.ON AND SCOTTISHPOWER RENEWABLES

These machines were built for utility customers, E.ON and ScottishPower Renewables. The P2-001 built for E.ON was the first wave machine to be sold to a utility for operation in the UK, and underwent a three year test programme before ownership of the machine transferred to Pelamis Wave Power. This machine will now inform ongoing research and development, testing numerous technology innovations in order to optimise Pelamis technology for commercial scale deployment.

The ScottishPower Renewables owned Pelamis machine, P2-002, was first installed in May 2012 and it is anticipated that the machine will continue its testing programme until 2015. The machine is being introduced to progressively more energetic sea states over time in order to test its performance in different conditions. The experience gained from this project will play a vital role in ScottishPower Renewables' plans to deploy a commercial scale wave farm off Marwick Head in Orkney, for which an agreement for lease has been awarded by the Crown Estate for up to 50MW capacity.

## TESTING HIGHLIGHTS

The P2 machines have now experienced around 90% of sea state occurrences for an average year, including significant wave heights of up to 5mHs, and individual waves of over 9m. This broad range of data from real sea testing is invaluable for the on-going development of the technology, allowing focused design and innovation for future enhancements of the Pelamis machine. These enhancements are vital to ensure that the costs of generating electricity from wave power continue to fall, in order to become cost competitive with other sources of offshore renewable energy.

The combined P2 test programme has now accumulated over 8500 grid connected operating hours, and exported almost 190MWh of electricity to the national grid. These are encouraging figures for this stage of the testing programme and it is anticipated that generated powers will continue to rise as the programme develops. These P2 operating hours bring the cumulative total for Pelamis technology up to well over 10,000 grid connected operating hours, demonstrating both the extensive experience of the Pelamis team and the wealth of learning delivered by the P2 testing programme specifically.

## PROVEN CAPABILITY

The proven average output capability of the device, over the annual spectrum of wave conditions at the EMEC site, is now close to 100kW. Demonstrations of further improvements are anticipated through control optimisation which could double that number as targeted for the next stage of the project.

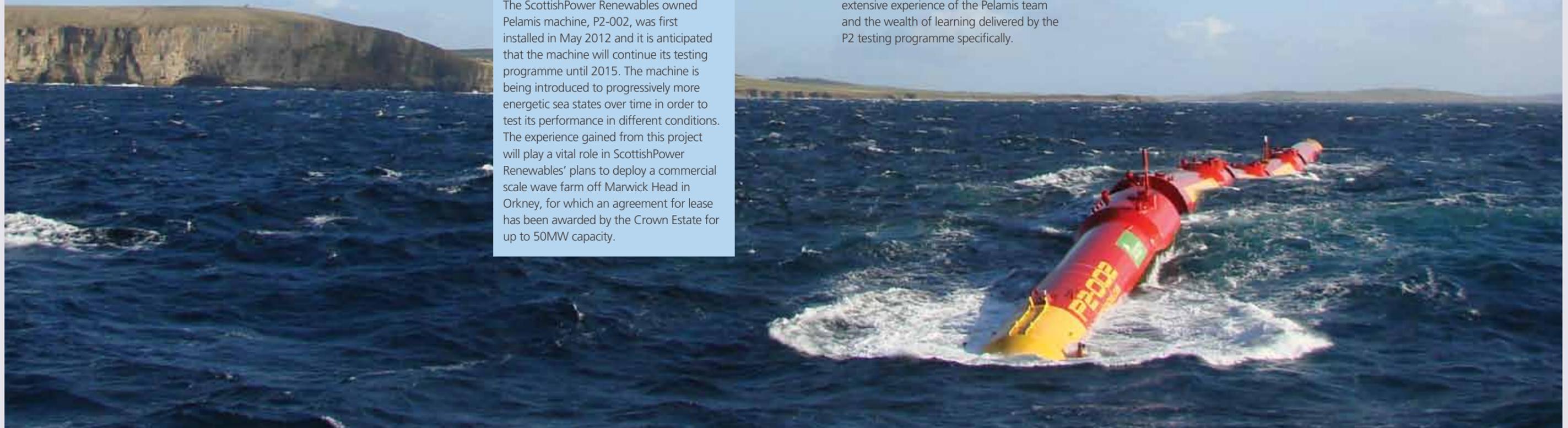
## 'PLUG & PLAY' SYSTEM

Pelamis' patented 'plug & play' system for the safe and rapid installation and removal of the machines in water has proved its strength and allowed for the towing and installation to be routinely conducted in wave heights of up to 2.5 metres as well as in darkness. This unique feature of the Pelamis P2 machine greatly expands the opportunities for operations and safe intervention, as it allows for flexible, round-the-clock operations, which is particularly important in the waters to the north of Scotland and over the winter months.

## OUTCOMES

The learnings from this P2 demonstration programme will inform larger projects under development in Scottish waters, as well as the technical optimisation of Pelamis technology in order to enhance performance and decrease the cost of energy from commercial scale wave power.

## Pelamis Wave Power



# Streams Ahead

With more wave and tidal stream devices installed in the UK than the rest of the world and an abundance of marine energy resource, the National Renewable Energy Centre (Narec) has over the past ten years played a pioneering role in developing and commercialising the industry.

Narec's marine and subsea testing facilities coupled with their research and development expertise has been key to the industry overcoming demanding technical and environmental challenges and helping the sector to achieve its current successes.

## FOCUS

With greater focus on proving technology, speeding up the development process and reducing costs before devices are installed offshore, Narec's controlled environment for accelerated life testing and proof of concept trials have attracted a number of device developers at various stages of development; helping to move technologies forward and bring innovative technologies to market much quicker.

## LOCATION

Situated on the river Blyth in Northumberland at the site where the world's first dedicated aircraft carrier HMS Ark Royal was built, Narec has adapted the three dry dock facilities to create a controlled onshore environment to perform prototype development, equipment trials, prove installation techniques, performance verification and witness tests for the offshore energy sector.

## CONTROLLED ENVIRONMENT

All of the docks offer Engineering, Procurement and Construction (EPC) contractors a real-life playground to trial their new technologies in a controlled environment, such as, novel pipeline and cable infrastructure installations, helping to reduce the risk of failure offshore.

## DOCK 1

The smallest of the three docks and contains a 50m long wave flume, for the testing of scaled prototypes. At 7m deep the flume is deeper than most facilities in Europe and can produce a range of different waves and sea states with waves up to 1.2m high.



## DOCK 2

Has an artificial seabed, made of clay and sand, characteristic of North Sea seabed conditions which has played an instrumental role in the testing and trialling of cable protection systems and novel cutting devices for trenching equipment.

## DOCK 3

Used as a large still water tank, allowing for the submerged testing of ROVs, tether management systems and subsea foundation structures.

## RESEARCH & DEVELOPMENT

Narec also continues to develop a strong R&D track record, initiating and delivering a number of National and European collaborative marine energy research projects, such as, predictive maintenance condition monitoring systems, the design and development of smart cable technology to improve the real-time understanding and performance, as well as, a purpose built inter-array cable trencher designed specifically for the offshore renewables market.

commissioning with the Atlantis Resources Corporation AR1000 turbine, Siemens-owned Marine Current Turbines (MCT) is the second client to utilise the facility and is currently undertaking a six month testing programme on the first of their 1MW powertrain units developed for the SeaGen-S 2MW device. The first of these tidal stream turbines will be deployed for commercial operation by 2015 at the Skerries Tidal Stream Array off the north-west coast of Anglesey in North Wales.

## KEY TESTS

One of the key tests which the facility is able to perform is accelerated lifetime testing, vital to understanding the performance of the device during its operational lifetime.

The rig will replicate the environmental forces and loads experienced on the turbine within a typical tidal stream such as those off the north-west coast of Wales.

## 3MW DRIVE TRAIN TEST FACILITY

In 2012 Narec opened a new 3MW drive train test facility for the testing of tidal turbine drive trains. Following the facility's successful

Matthew Reed, Engineering Director, MCT: *"The Narec facility provides us with the opportunity to perform extensive characterisation and endurance testing of our latest tidal turbine powertrains allowing us to fully load the powertrain for prolonged periods of time, both in terms of rotor power (torque and speed) but also the spectrum of rotor thrust loads. The versatility of the Narec facility also allows our complete grid connection system to be included in the test, enabling us to prove the quality of the design prior to deployment in turbine arrays."*

The drivetrain is also capable of testing individual components as well as the whole system and has attracted interest from bearing and gearbox manufacturers.



## UKAS ACCREDITATION

At present, subsea power cables and supporting infrastructure are major elements required for the development of the offshore industry, especially in the wave and tidal industry where they are exposed to harsh, dynamic environments. Improving their performance and reliability is, therefore, a key factor in helping to lower the cost of offshore renewable energy. Narec's UKAS accredited electrical and materials laboratories have worked on a number of cabling projects, certifying new cables and subsea connector designs, developing power take-off systems for wave devices and carrying out failure analysis investigations. The lab also conducts type testing of medium-high voltage cables, cable joint integrity tests, salt corrosion analysis and materials and coatings selection.

## CONFIDENCE AND REASSURANCE

Testing and innovation development provides the industry with confidence and reassurance, Narec is key to ensuring project developments progress and continue as planned, helping to encourage further investment and the wider supply chain to make the transition into the marine renewables industry.

Narec



SmartBay manages Ireland's national test and demonstration platform for the development of innovative products and services for the global maritime sector. This facility supports the collection of marine data for the national and international R&D communities and the trial, demonstration and validation of novel marine sensors and equipment.

They provide communications, marine, information and technology services to various sectors including; ocean energy, shipping and security, aquaculture and environmental monitoring.

# IRELAND'S NATIONAL MARINE TEST & DEMONSTRATION FACILITY



**SUPPORT**

SmartBay Ireland supports the testing and validation of novel sensors and equipment for its clients and provides platforms and sub-sea facilities for the test and demonstration of new technology and solutions. Clients can access their cyber environment to validate new solutions for marine and related sectors.

**DEDICATED TEAM**

SmartBay has a dedicated team of scientists, mechanical, electronic and communications engineers and software developers, supported by experienced marketing and business development professionals with extensive marine industry knowledge and experience.

This combination of skills allows them to offer its users an end-to-end service from initial product conception to commercialisation.

**FACILITIES**

Ireland's national test site is ideally located within the confines of Galway Bay. Sheltered from the high-energy seas of the Atlantic by the Aran Islands to the West, the hills of Co. Clare to the South and surrounded by Co. Galway to the North and East. The test site is located approximately 4.5km's East of Spiddal; approximately 1.5km's offshore with a water depth of 23m.

**GALWAY BAY (¼ SCALE) TEST SITE**

The Galway Bay test site is an ideal base for ¼ scale wave and wind energy devices as it provides an excellent oceanic wave regime, sheltered harbour facilities and the renewable, maritime and environmental expertise that exists within the area. The ¼ scale test site allows smaller scale devices, or those at an earlier stage in their development, to gain sea experience in less challenging conditions than those experienced at the full-scale wave and tidal test sites.

The buoys can host a variety of communications protocols including; GPRS, Satellite, VHF, Wimax, GSM, 3G, Wi-Fi. The buoys have a high performance / low power data acquisition and transmission system and a large power capacity for hosting multiple sensors. SmartBay buoys are of robust construction and have a high stability in operation.

The sub-sea cabled observatory includes; fibre optic data and 400v power cable, high speed communications via 10 pairs of optical fibres and a sub-sea cabled sensor platform which will host of variety of sensors and equipment which can be tested and demonstrated in near real-time.

The cabled observatory will include a range of 'off-the-shelf' sensors and equipment including; a CTD, ADCP, Hydrophone, HDTV and Nutrient Monitoring sensors. Dedicated ports will be allocated for the



**SERVICES**

The team of marine communication and electronic technicians allows them to offer a range of marine services to all users of the test and demonstration facility. This allows their clients to focus on device validation and product development. Each project is guided from initial concept through to commercialisation.

They also offer a complete range of marine services to all users of the national marine test and demonstration facility and their experienced technical team can provide bespoke innovative solutions to the unique problems that testing in a marine environment presents.

**MARINE ICT SERVICES**

SmartBay provides a real-time data acquisition system for transmitting, collecting, parsing and storing data, which is then made available on the web. The company also offers bespoke data processing and presentation solutions to their clients including; data collection, data management, data visualisation, secure access, a range of file formats and test site hindcast datasets (acoustic, wave height, tidal etc.).

**DATA DELIVERY PORTAL**

Providing a real-time data solution, SmartBay's custom built portal offers; sensor data collection from NMEA and non-NMEA sensors, tailored data acquisition timing intervals, customised data pre-processing, validation and parsing, collection and access to raw and parsed data and access to data in a variety of formats.

Ancillary power and a range of wireless communications are also available on site. Wave energy devices that have been successfully deployed at the test-site since its inception include WaveBob and Ocean Energy.

**Infrastructure**

**BUOY NETWORK**

SmartBay operates a fleet of Mobilis DB5800 buoys used for testing a range of environmental and meteorological sensors. The data generated by these sensors is transferred back to SmartBay headquarters via a variety of wireless communication options and onto users globally through the SmartBay online portal.

**SUB-SEA CABLED OBSERVATORY**

Science Foundation Ireland has facilitated the acquisition and installation of an underwater cabled observatory which will run from Spiddal to a distance of 4.5 km east of Spiddal pier, Galway Bay and which will be operational by the end of 2014. The cable will terminate at an underwater node which will provide power to, and collect data from, underwater sensors which will be connected to the sub-sea observatory. The cable will also be connected to a large power buoy which will be used to feed additional power to, and dissipate power from, prototype wave energy devices which are being tested at the ¼ scale ocean energy test site.

testing of prototype sub-sea sensors and equipment.

**HORIZON 2020**

SmartBay Ireland as an SME is looking to collaborate in Horizon 2020 through any marine based or marine section of a call from ICT, software development to marine trial and demonstration. We are keen to talk to potential partners and to explore research opportunities from a H2020 perspective.

SmartBay Ireland



[Click to view more info](#)

[Click to view video](#)

# THE CENTRE FOR ADVANCED SUSTAINABLE ENERGY (CASE)

CASE, the latest of a series of Competence Centres funded by Invest Northern Ireland in 2013, is a research organisation which brings together the renewable energy expertise of Queen's University Belfast (QUB), University of Ulster (UU) and the Agri-Food and Biosciences Institute (AFBI) to meet the research needs of industry.

## REMIT

CASE has a wide-ranging remit and supports research i.e. ....

- The grid : Demand Side Management
- Energy from biomass
- Turbines (wind, wave and tidal)
  - a) Innovative site survey and characterisation methods
  - b) The use of composites and new or hybrid materials
  - c) Resource modelling and site assessment
  - d) Blade, gear box and generator innovations

## QUB

QUB has been involved in marine energy since the 1970s and nine leading devices have been tested and developed at the QUB Environmental Engineering Research Centre (EERC) over the last 10 years.

## EERC

The EERC has two wave tanks including a new, wide facility at Portaferry at the mouth of Strangford Lough. With its cross-current capability this wave tank will be valuable in understanding the impact of arrays on coastal processes.

## COLLABORATION

In addition, EERC works closely with Aquamarine power and Wavegen on prototype testing of their wave energy capture devices and was instrumental in the deployment of Marine Current Turbines' SeaGen tidal turbine in Strangford Lough, supporting this project with...

- Tidal resource characterisation
- Real-time monitoring during deployment
- Pre-installation environmental monitoring
- Post-installation environmental monitoring
- Turbine performance assessment

Recent research by EERC in conjunction with CASE involves a collaboration of five companies in the evaluation of the impact of tidal turbines in a small array. Two Oceanflow 1/10th scale Evopod devices have been tested in tandem in calm conditions on a local lake and in real sea conditions at Strangford.

## ENTERNI PROJECT

CASE has been working with industry to determine the most suitable location for a tidal turbine commercial demonstration site to be based in Northern Ireland through its EnTERNI Project. Initial research and development work on the North Coast will focus on areas as diverse as marine archaeology, geophysics, flow monitoring and the understanding of benthic ecology.

## The Centre for Advanced Sustainable Energy



## Research Capability in Wave & Tidal Energy

Northern Ireland has been a leading location for research in wave and tidal for over 30 years and has been recognised globally for its expertise. By 2012, according to figures from the Global Maritime Alliance, one in four marine energy devices had been tested, manufactured, designed or consulted on in Northern Ireland.

### QUEEN'S UNIVERSITY BELFAST (QUB)

In particular, QUB has a global reputation for its pioneering work in the research and development of marine energy technologies.

Professor Trevor Whittaker, who leads a 25 person team, has worked in this area for over 30 years. He is one of the industry's pioneers, having been involved in the design and installation of both the UK's first and second grid-connected wave power plants on the Isle of Islay in Scotland in the 1980s and 1990s.

### EXPERIENCED TEAM

He and his team also designed and tested Oyster I and Oyster II as well as LIMPET wave power devices.

QUB was also the first in the world to undertake an environmental monitoring of a full-scale marine device – research which lasted for over five years. The team also has expertise in prototype development and testing; modelling (physical, environmental and numerical) and concept evaluation.

### FACILITIES

Much of the research has utilised the first class facilities at the university. A World Centre of Excellence for marine energy, it has wave tanks located at Portaferry and Belfast. These provide variable wave and current generation and speeds and the one located in Portaferry is unique in that it tests shallow water depth rather than deep water.

### CENTRE FOR ADVANCED SUSTAINABLE ENERGY (CASE)

Northern Ireland boasts 15 research centres across all areas of renewable energy. One of the newest is the competence centre – CASE, an industry led research centre which focuses on a number of different areas including wave and tidal.

### ENTERNI PROJECT

Among the ventures they have been involved with so far is the EnTERNI project - a proposed tidal array testing facility off the northern coast of Northern Ireland.

In terms of research and development, it is hard to beat what Northern Ireland has to offer.

### Invest Northern Ireland



## Case study: BELFAST HARBOUR

**Established in 1847, Belfast Harbour Commissioners is the port authority in Belfast and operates the principal maritime gateway on the island of Ireland. Covering an area of over 800 hectares it is one of the UK's largest ports handling a record 22.9 million tonnes of cargo in 2013.**

### COMMITMENT

The port has demonstrated its commitment to the renewable energy sector by developing the UK's first purpose-built logistics terminal for the offshore wind industry, leased to DONG Energy and under use for the build out in the East Irish sea of ScottishPower Renewables' and DONG Energy's West of Duddon Sands offshore wind farm, which began construction in 2013.

### FACILITIES

The facilities at Belfast Harbour include Ireland's longest deep-water quay, Stormont Wharf, at over 1km long. It has over 40 ha of strategically located waterfronting development sites available for large-scale manufacturing and logistics activity for the offshore renewables sector. The port's main shipping channel provides 24x7 access, with a maintained depth of 9.3m providing access to berths of depths up to 11.5m.

### HARLAND AND WOLFF

One of the largest facilities in the port is operated by the world famous, Harland and Wolff Shipyard. Harland and Wolff's facilities include extensive dry dock facilities, with over 100,000m<sup>2</sup> of storage areas and two permanent heavy lift gantry cranes each with a lifting capability of up to 800 tonnes.

### UK'S LEADING RENEWABLE ENERGY HUB

Over recent years Belfast Harbour has capitalised on these facilities to become one of the UK's leading renewable energy hubs suitable for supporting offshore wind and the wave and tidal energy sector.

Crucially, Belfast Harbour has demonstrated to the renewable energy sector, its expertise and track record of delivering major port infrastructure projects on budget and within required timescales. These attributes make it a sought-after port partner for the marine renewable energy sector.

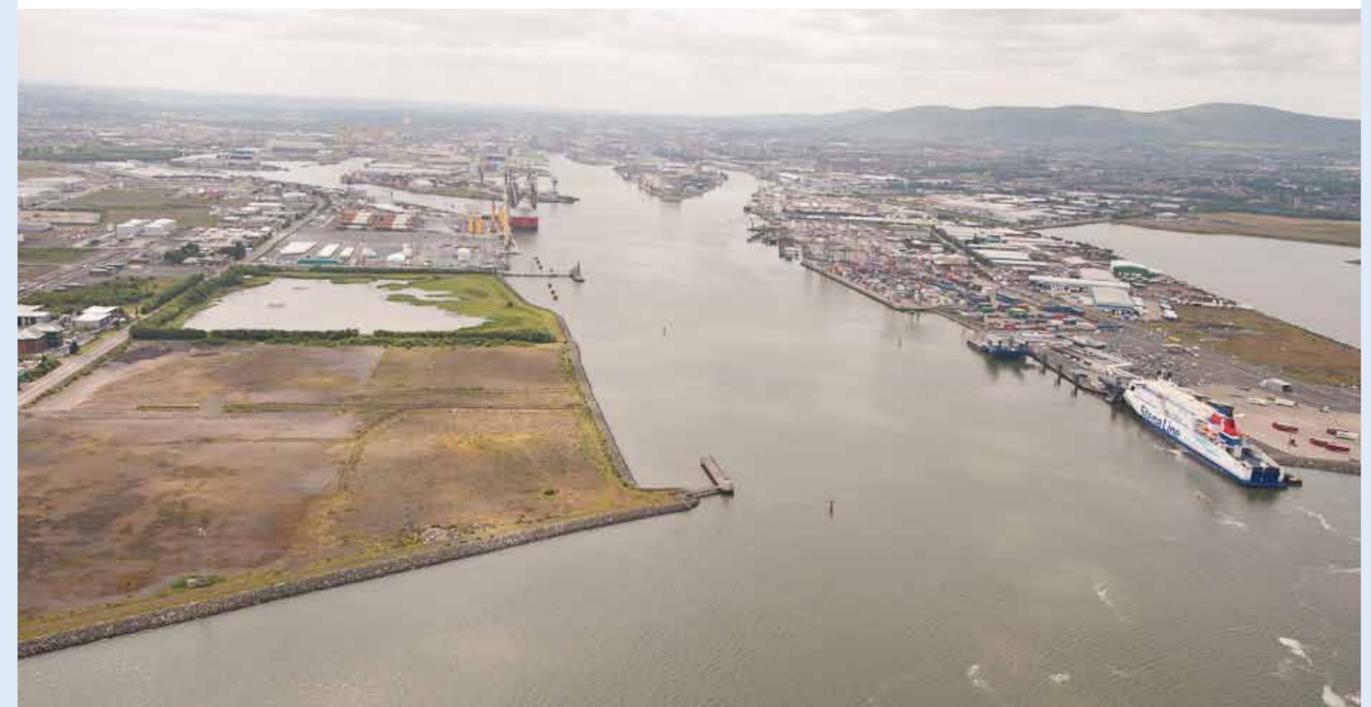
### HIGH PROFILE TIDAL ENERGY SUPPORT

As a result, Belfast Harbour is rapidly establishing itself as the leading hub port in the UK for offshore wind and marine renewable Energy Industries with high profile tidal turbines such as Marine Current Turbines' 1.2MW SeaGen and Scotrenewables SR250 both being assembled by Harland and Wolff in Belfast Harbour.

### FUTURE OPPORTUNITIES

Future opportunities for Belfast Harbour include providing facilities for large scale marine energy device manufacturing and providing the marine logistics base from which to execute wave and tidal energy projects in Northern Ireland's territorial waters, Scottish territorial waters and further afield.

### Belfast Harbour



# FOLLOWING 20 YEARS ONSHORE DP ENERGY DIPS TOE INTO TIDAL

One of Europe's longest established onshore wind farm development specialists is testing the waters for the first time with a new set of tidal generation schemes.

## DP MARINE ENERGY (DPME)

Cork-based DP Energy founded by Maureen and Simon De Pietro over two decades ago has created a new subsidiary, DPME to develop utility grade and large megawatt capacity tidal and wave energy projects in key markets worldwide.

DP Energy director Simon De Pietro says DPME is one of a number of renewable energy development companies in the DP Energy stable.

## EXPANSION

"DPME's initial focus is on tidal energy in UK & Irish waters and the Canadian Maritimes," said Simon. "We are aiming to expand DPME's existing projects which include a 100MW scheme off Fair Head, Co Antrim partnered with Belgian offshore specialist DEMA Blue Energy. We are also working on another 30MW tidal project off West Islay with a view to building a portfolio of de-risked, shovel ready, or perhaps bucket ready, projects for a collective portfolio funding round."

"The first of these projects, West Islay, is likely to receive a Section 36 consent in summer 2014."

## UNIQUE

Simon added that DPME is unique in the marine field. Explaining; "Whilst the company is staffed largely by engineers and seeks to understand and help develop engineering solutions to some of the technical challenges it is a technology-neutral project developer."

"The approach is firmly based on the fact that the site and project internal rate of return (IRR) comes first and that technology is simply a means of reaching that IRR."

"A technology-neutral approach results in a broad Rochdale Envelope on consenting which means leaning towards open rotor, horizontal axis machines whilst remaining agnostic on the support structure - gravity, pin piled, surface piercing, non-surface piercing or floating."

"This ensures projects are buildable in the future as the least costs solution develops as the industry matures and ensures potential competition in the market."

Despite remaining technology-neutral, DPME is partnering a project specific basis with credible OEMs and with demonstrated and competent technologies.



## CONSORTIUM

The firm is also leading a consortium which has been awarded a grant of £8 million from the European Commission Seventh Framework Programme for a demonstration tidal array on Fair Head with Siemens MCT and is working towards a demonstration in the Bay of Fundy Nova Scotia in conjunction with Andritz Hammerfest.

"DPME is committed to the marine tidal and in-stream current sector and has interest in run of river with smaller subMW class machines and we also have a developing interest in wave albeit recognising the significant technical challenges."

"DPME's aspiration is to be the lead independent tidal energy project developer in Atlantic Waters (and potentially beyond)."

DP Energy has produced some 215MW onshore built projects of which 117MW are now consented.

DP Energy

# WAVE VERSUS TIDAL?

## OUR SEAS HAVE ROOM FOR BOTH

As an island nation, we have huge wave resources in the seas surrounding us. Provided that wave power technologies are sufficiently commercialised, this presents huge social and economic advantages for the UK.

### FUNDAMENTAL ISSUE

One of the fundamental issues facing the offshore renewable energy sector today however is whether continued investment in wave power technologies makes economic sense. Many stakeholders view wave power as an expensive technology, requiring large sums of money to prototype and commercially test large units.

Over the last few years, tidal power development has arguably overtaken wave power development in the UK. There are now more, and bigger, tidal prototypes in our waters than wave devices because the industry has attracted investments from some of the industrial manufacturing powerhouses, a pattern that is yet to be repeated in the wave industry.

This is sometimes seen as a sign that, as far as engineering competence and investor confidence is concerned, it's better to back tidal than wave power.

### WORLD LEADERS

Let's not forget, though, we are the world leader in developing wave power, just as we used to be a world leader in developing wind power, before insufficient demand and investors in the industry saw other countries, particularly in Scandinavia, overtake us. So we must act now to ensure this doesn't happen to the wave power sector, and to ensure that we maximise the social and economic opportunities for the UK.

### MAKING WAVE COMMERCIALY VIABLE

Wave power devices operate in much more challenging conditions than wind and tidal turbines, and so more needs to be done to the devices themselves to prove the technology and ensure they are reliable enough to withstand harsh sea conditions over a number of years. Proving that the energy to weight ratios delivered by wave devices can deliver electricity at a commercial price that is acceptable to investors to attract them to the industry.

We've progressed quickly to testing large scale wave machines, but deploying just one or two of these machines at test centres like EMEC in Orkney can run to tens of millions of pounds. And to fully prove new wave technologies, you need to deploy them in arrays large enough to achieve scale and properly assess performance capability. This is an important, but even more expensive, step.

### FUTURE SUCCESS

We need device developers to focus on improving the devices themselves, and getting the technology right to convert wave power into electricity. The Catapult's role will be to work with them and others, particularly academia, to focus research priorities around wider critical path components which have less to do with a developer's intellectual property, and more to do with issues around reliability, health and safety, installation methodology, and electrical connections.

### PROVING VIABILITY

Ultimately, to prove the viability of wave power, we need to see bigger devices in the water, and more of them. Our aim, as a nation, should be to establish a wave device test array. For all new technologies, this is a necessary step to prove the technology works and is commercially viable.



Andrew Jamieson

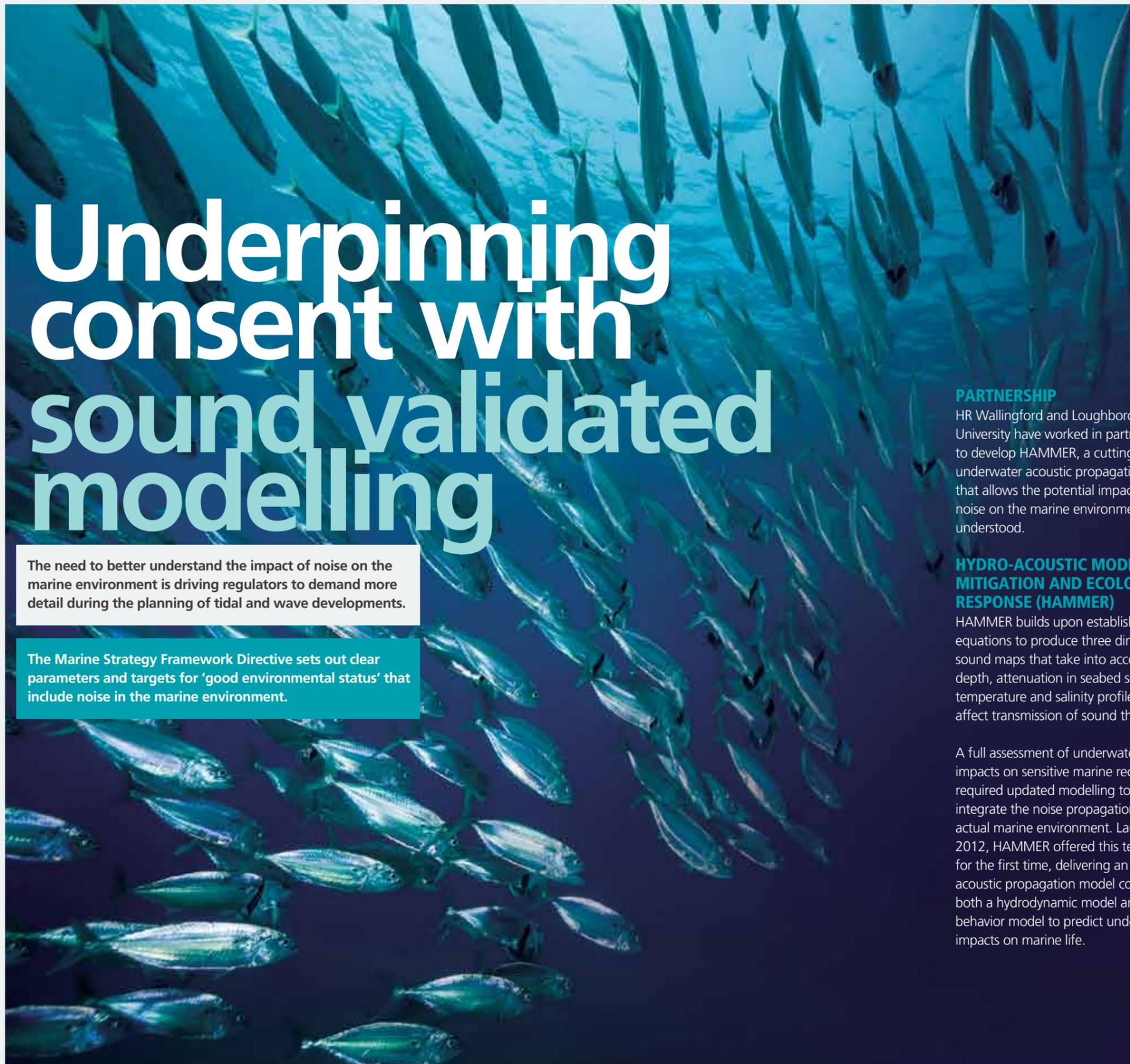
### STARK CHOICE?

With marine technology, people often think it's a stark choice. Is it tidal, or is it wave?

I think there is room for both. The science is sufficiently developed to show that there is potential for extracting energy from waves, and so we should all – industry, academia and government – be working towards this goal, whilst at the same time working hard to improve the technology of the devices themselves.

The more you can resolve some of the basic issues that developers come up against time and time again, the less risky and more attractive wave projects will become to investors.

**Andrew Jamieson**  
CEO  
Offshore Renewable Energy Catapult



# Underpinning consent with sound validated modelling

The need to better understand the impact of noise on the marine environment is driving regulators to demand more detail during the planning of tidal and wave developments.

The Marine Strategy Framework Directive sets out clear parameters and targets for 'good environmental status' that include noise in the marine environment.

## UNDERSTANDING POTENTIAL IMPACTS OF NOISE ON SENSITIVE SPECIES

The realistic prediction of the noise propagated from construction of marine renewable devices can be used by the renewable energy industry to understand the potential impacts of noise on sensitive species at their development sites. Moving forward, this will allow project developers to develop effective monitoring and mitigation plans for underwater noise as the UK moves towards the first commercial tidal turbine arrays.

## PERFORMANCE

HAMMER has been extensively tested and has performed well against existing sound models in bench mark tests. In 2013 HAMMER was validated using pin-piling and ambient noise data collected from a boat-based hydrophone during the construction of the SeaGen tidal turbine in Strangford Lough, Northern Ireland.

Data provided by Marine Current Turbines Ltd, for both discrete frequencies and for broadband sound, i.e. several frequencies at one time, was compared to the transmission loss predicted by HAMMER. The high level of accuracy shown (90%) for all those frequencies tested indicated that the model provided realistic predictions of underwater noise propagation from the pin piling along the measured transects.

## PREDICTING TRANSMISSION LOSS

The modelling tool can be used to predict the transmission loss from a variety of noise sources for EIA purposes including turbine operation, pile driving, mobile vessels (e.g. dredgers), mechanical components of a device and anchor chains. Three dimensional sound maps of the underwater noise levels are produced and can be interpreted in relation to the hearing sensitivities of the marine mammals in the area to produce 'zone of influence' maps for each species.

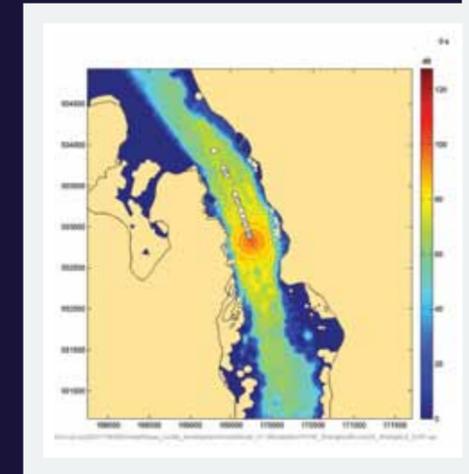
## PARTNERSHIP

HR Wallingford and Loughborough University have worked in partnership to develop HAMMER, a cutting edge underwater acoustic propagation model that allows the potential impacts of noise on the marine environment to be understood.

## HYDRO-ACOUSTIC MODEL FOR MITIGATION AND ECOLOGICAL RESPONSE (HAMMER)

HAMMER builds upon established parabolic equations to produce three dimensional sound maps that take into account water depth, attenuation in seabed sediments, temperature and salinity profiles which affect transmission of sound through water.

A full assessment of underwater noise impacts on sensitive marine receptors required updated modelling tools that integrate the noise propagation into the actual marine environment. Launched in 2012, HAMMER offered this technology for the first time, delivering an underwater acoustic propagation model combined with both a hydrodynamic model and a species behavior model to predict underwater noise impacts on marine life.



HAMMER allows underwater noise levels to be mapped

## ONGOING DEVELOPMENT

Development of the HAMMER tool continues. In particular, research is being carried out that looks into the response of fish to noise and is being undertaken as part of a three year NERC studentship to produce data to drive the ecological response model, allowing greater certainty of the ecological impacts of underwater noise.

HR Wallingford  
Founding Partners

[Click to view more info](#)

[Click to view video](#)



# Success for Subsea Acoustics Survey at Isle of Wight Tidal Energy Site

Kongsberg Subsea Environmental Monitoring Group and North Sea Systems have partnered to successfully monitor underwater noise at an Isle of Wight tidal renewables energy site.

The company conducted an underwater noise monitoring programme at a location at the western end of The Solent that has been identified as a Nursery Site earmarked for marine renewables. Located just off Yarmouth, and having a peak tidal stream flow rate of 4 knots, the site is regarded as one of the prime locations in the South for potential tidal turbine development programmes.



AMBS topside

## SUCCESSFUL DEPLOYMENT

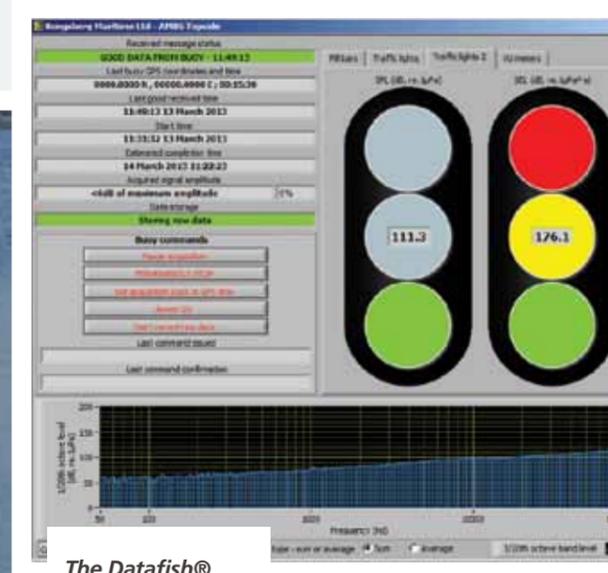
The project saw a successful deployment of the Kongsberg Passive Acoustic Monitoring System (K-PAMS) to measure underwater noise levels within the location, using North Sea System's DataFish® buoy. K-PAMS recorded underwater noise continuously over a 4-day period. The data consisted of underwater noise levels in the absence of any recognisable noise source as well as noise from passing vessels.

## DATA COLLECTION

Following collection of the data, engineers correlated AIS vessel movements with specific noise events in the data record. The DataFish® buoy provides an ideal platform for such a survey, not only for powering the instruments, but also for transmitting the data in near real time.

## MONITORING POTENTIAL ACOUSTIC IMPACT

Establishing baseline underwater noise levels in this way will enable renewables developers to monitor any potential acoustic impact of marine turbines and vessel movements on marine life especially dolphins, porpoises and seals. This work will continue to support renewables project consenting on the Isle of Wight Nursery site.



The Datafish® tidal survey device, manufactured by North Sea Systems

Peter Ward, Kongsberg Maritime Product Manager for K-PAMS, said the fact that DataFish® could be used for acoustic monitoring over extended periods of three-to-six months, allowed K-PAMS to be deployed in a wide variety of applications such as acoustic data gathering for marine energy environmental impact assessments; shipping noise surveys; and during construction projects where impact piling or explosive noise can be problematic.

## CURRENT DEPLOYMENT

Kongsberg currently have K-PAMS deployed at an offshore wind farm development in the North Sea close to the Dutch-German maritime boundary. The K-PAMS functionality allows the operators to monitor impact noise levels in real time using a simple traffic light system where 'green' means that noise levels

are OK, 'amber' means that thresholds are close to being met and 'red' indicates that noise thresholds have been exceeded and that mitigation procedures should be implemented.

## NURSERY SITE PROJECT DETAIL

During the Nursery site project, the K-PAMS hydrophone was installed between the Datafish® buoy and its mooring and measured acoustic activity, feeding back instantly to the data collection point. This has allowed the Kongsberg Maritime engineers to start building a picture of marine activity, so the effect on future tidal site development can be monitored, and the potential impact on the marine environment can be determined.

## FASTEST-GROWING SERVICES PORTFOLIO

Peter commented: "The renewables sector is one of the fastest-growing areas of Kongsberg Maritime's services portfolio, and we are pleased to have been able to work in partnership with North Sea Systems in this project. I am certain that the data collected during the deployment will be critical to the future development of this key tidal energy site."

## SAFELY AND ACCURATELY DEPLOYED, RECOVERED AND RELIABLY OPERATED

"Lost equipment, failed deployments and poor quality data in highly energetic environments have plagued tidal turbine and wave energy developers in the marine energy industry in recent times. In bringing together K-PAMS and DataFish® we have created a system that can be safely and accurately deployed, recovered and reliably operated." Peter concluded.



Kongsberg Maritime

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# OCEANUS 2

## Construction Begins

UPSCALED SUCCESSFUL WAVE ENERGY DEVICE IS NOW UNDERWAY.

Pioneering wave energy developer Seatricity is celebrating the start of constructing its new Oceanus 2 device with leading marine fabricator A&P Falmouth following the highly successful testing of its Oceanus 1 prototypes.

Seatricity's MD, Peter Mitchell, joined A&P's Renewable Energy Technical Manager, Paul Weston, at A&P's Falmouth workshops to toast the first fabrication of this new generation of wave energy devices which will soon be undergoing sea trials at Cornwall's Wave Hub.

### 2 YEAR PROGRAMME

Each Oceanus 2 device will have a name plate electrical output of 160KW and Seatricity plans to develop an array of 60 devices over the next two years to produce a full-scale 10MW connected to the UK grid.

### SPECIFICATION

Constructed in aluminium and steel, measuring some 11 metres across and weighing more than 8.5 tons, the Oceanus 2 floats on the sea surface using the wave swell and unique pumping technologies to create a smooth and consistent high pressure flow of water to drive turbine generators.

The device is also capable of creating fresh water using the reverse osmosis desalination process - either separately, or at the same time as generating electricity - making it a genuinely unique and vital solution for many markets.

### NEW DAWN FOR WAVE ENERGY

Peter Mitchell said "The start of Oceanus 2 production marks what we believe to be a new dawn for wave energy."

"Up to now wave devices have often been overshadowed by other renewables."

"However, the outstanding results and survivability we have achieved with our prototypes in very harsh conditions at the European Marine Energy Centre (EMEC) have demonstrated the practicality of our devices making a real contribution to renewable electricity - not only in the UK, but in many other countries as well."

"We are very excited to be here at the beginning of this final leg in our journey!"

### EXTENSIVE JOINT SKILLS

Paul Weston added "We are delighted to start the construction of Seatricity's Oceanus 2 devices."

"In doing so we are bringing together our extensive knowledge and fabrication skills at A&P to provide a unique service which clearly demonstrates the value of our in-depth experience in marine engineering."

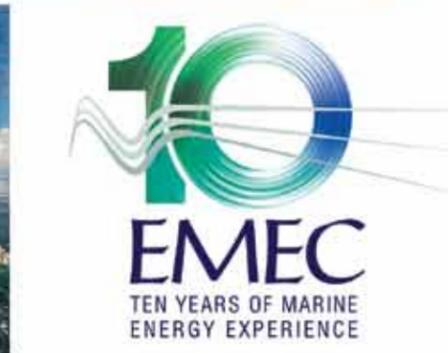
"It also demonstrates how important Cornwall is becoming in the supply chain to this relatively young, yet very important, new industry of renewable wave energy."

The first Oceanus 2 devices are due in the water in Spring 2014 at the Wave Hub offshore renewable energy test facility site ten miles off the coast at Hayle, close to A&P's workshops at Falmouth.

**Seatricity**



Paul Weston (left) and Peter Mitchell (right), with hull sections ready for the first fabrication.



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# THE POWER OF THE TIDES

The possibility of taking advantage of the power of the tides has been something that has excited engineers for decades, if not centuries, but bringing that dream to fruition has proved more difficult than anyone has imagined.

With the advent of new technologies, many of which come from the wind and hydro sectors, the possibility of harnessing tidal streams is finally coming closer and Alstom is at the forefront of that possibility.

## DEDICATED TEAMS

With dedicated teams in Nantes and Bristol, Alstom is developing the next generation of tidal energy technology.

Their 1 MW tidal turbine is currently on test at the European Marine Energy Centre off the coast of Orkney. Late last year it reached the impressive milestone of having generated 100 MWh of electricity.

## MOU

Successes such as that have led to Alstom signing and Memorandum of Understanding with ScottishPower Renewables to incorporate Alstom's tidal power devices into the Sound of Islay project which will see four of Alstom's 1 MW tidal devices deployed between the islands of Islay and Jura on the west coast of Scotland.

The Islay programme remains on schedule for the first unit to be deployed in late 2015, with full site deployment during 2016. Operations are planned for 25 years and the demonstration project is anticipated to be the launch pad for future larger scale sites around the Scottish coast.

*"We believe the potential for tidal power in the UK is huge and with our turbine, we have the ability to help our customers make the best of that potential,"* said Alstom Ocean Vice-President Rob Stevenson.

## SPECIFICATIONS

Alstom's tidal turbine consists of a three-bladed, pitch-controlled rotor, with a diameter measuring 18 metres, a standard drive-train and power electronics inside the nacelle. The 22m long nacelle is installed onto a separate seabed-mounted foundation and weighs less than 150 tonnes.

## FEATURES

The tidal stream turbine has a number of notable features...

1. It is simple and easy to transport. Its buoyancy means that it is easily installed and retrieved in a single tidal cycle using small vessels, reducing installation and maintenance costs.
2. It has an intelligent nacelle. Thrusters rotate the nacelle to reflect the direction of the tide, managing ebb and flood tides seamlessly as well as maximising energy production.
3. With its efficient blades, turbine blade pitching can be altered to control load on the turbine and optimise use of the tidal conditions locally.

Tests on the turbine will continue throughout 2014, followed by deployment in the Sound of Islay and then on to commercialisation when the dreams of many engineers will finally come to fulfilment.

## Alstom



# AN OVERVIEW OF THE WAVE AND TIDAL SECTOR THE CHALLENGE

Harnessing the energy generated by waves and tides to create clean, renewable electricity is a reality. The challenge for this burgeoning industry is to generate energy safely, reliably and at a commercially competitive scale and cost.

Wave and tidal developments are located in challenging physical environments. As a result their tidal turbines and wave devices are at the cutting-edge of marine engineering technology. The industry has the potential to produce significant and predictable energy, locally, nationally and internationally.

### ROYAL HASKONINGDHV

As an industry leader, providing environmental and engineering support to the wave and tidal energy market since 2003, the company is at the forefront of the sector and well-known for its role in the assessment and consenting, as well as supporting the installation and operation of a number of world leading projects.

### SEAGEN

These include SeaGen in Northern Ireland, the world's first grid-connected commercial scale tidal turbine, and the world's first tidal turbine array in the Sound of Islay, Scotland.

Royal HaskoningDHV is actively involved in the design and installation of smaller hydro electric projects and has implemented several such projects across Europe.



### PROJECT ASSISTANCE

While best known for successful site feasibility studies, managing and delivering EIA processes, stakeholder engagement and supporting the consenting processes of large-scale wave and tidal projects.

The company's multidisciplinary team of engineers and environmental scientists is able to help developers and manufacturers at every project stage. From site selection through development and construction to post-construction maintenance and monitoring, their extensive experience and creativity enable them to deliver dynamic, practical and cost-effective solutions for a wide range of wave, tidal and hydro engineering and consenting challenges.

### RAPID PROGRESS

The commercialisation of wave and tidal energy is progressing rapidly - made possible by government support and the availability of significant, accessible wave and tidal resources.

Internationally, wave, tidal and hydro projects are also increasing in number, particularly in Europe, North America, South America, the Far East and Australasia.

Frank Fortune  
Royal HaskoningDHV

[Click to view more info](#)



# ADVANCING TIDAL RESOURCE MODELLING FOR THE UK

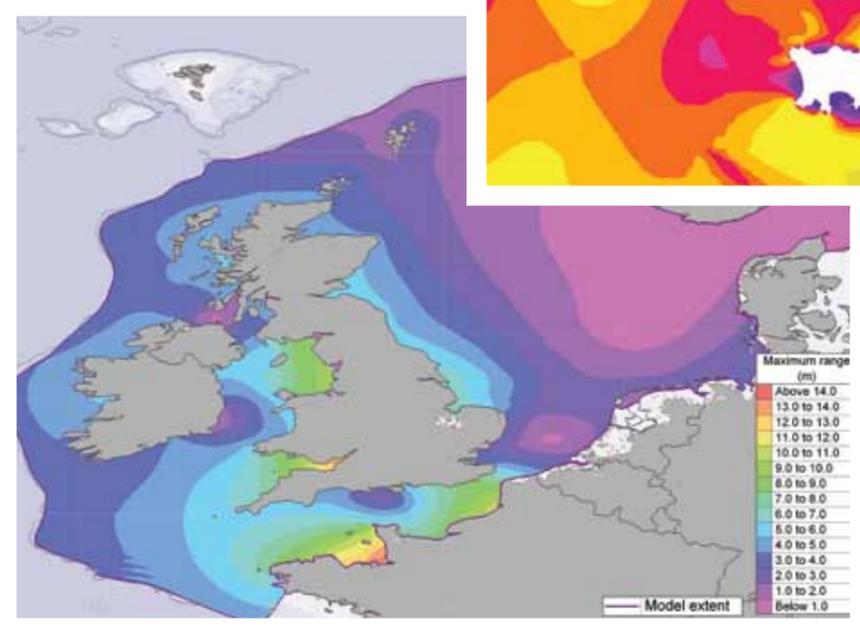
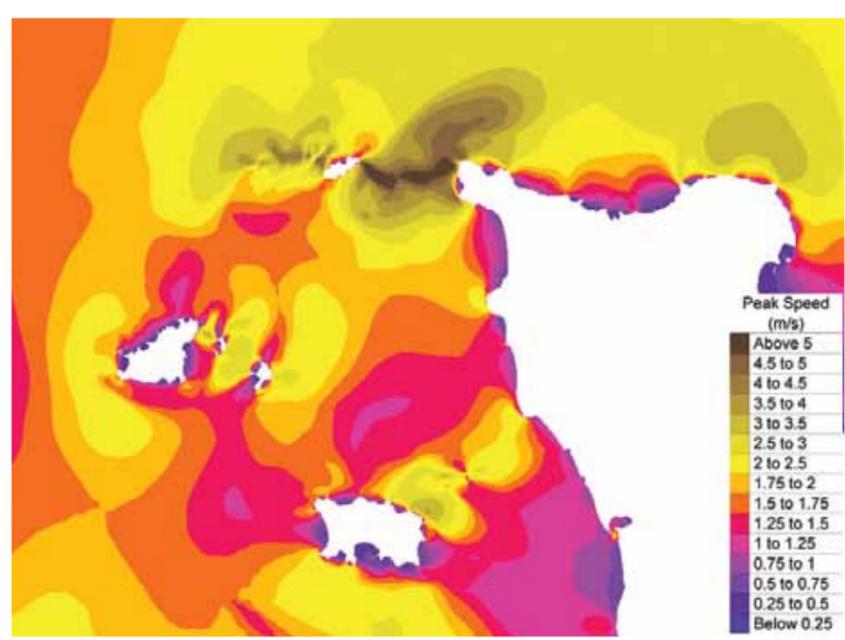
**The need to increase energy security and provide sustainable energy generation has never been greater. To date, advances within the tidal energy industry have been on marine renewable innovation with a primary focus on proving a tidal technology from concept to small scale operation and demonstration devices.**

The UK is currently a global leader in marine energy with ground breaking test facilities and more installed devices than the rest of the world. The next phase for this sector is the race to overcome the complex engineering challenges presented by installing the first tidal energy arrays. SMARTtide will help to maximise tidal energy potential within the UK continental shelf

## SMARTTIDE (SIMULATED MARINE ARRAY RESOURCE TESTING)

In this context, HR Wallingford and the Energy Technologies Institute (the ETI) launched SMARTtide in 2013. SMARTtide is a unique 2D tidal energy modelling tool

designed for use by the tidal energy industry. One of the immediate uses of the powerful suite of models is to identify the most efficient sites for tidal energy converters, tidal arrays or tidal barrage schemes around the UK and French coastlines.



**THE MODELLING TOOL WILL HELP DEVELOPERS IDENTIFY THE MOST EFFICIENT SITES FOR TIDAL ENERGY DEVELOPMENTS. THIS EXAMPLE SHOWS PEAK CURRENT SPEEDS IN THE WATERS AROUND ALDERNEY IN THE CHANNEL ISLANDS.**

It also calculates how energy extraction at one site may affect the energy available elsewhere. It identifies how interactions between different sites around the UK combine to form an overall effect. Importantly, it considers what constraints these interactions will place on the design, development and location of future energy systems.

## COLLABORATION

SMARTtide follows from an earlier project commissioned and funded by the ETI, led by Black & Veatch, in collaboration with HR Wallingford and the University of Edinburgh.

Since its launch, the modelling tool has attracted considerable interest from the tidal energy industry, with a particular interest in the baseline tidal data from the validated model which provides an invaluable understanding of the tidal resource key to siting the best suited technology.

## KEY ADDITION

Graham Siggers, HR Wallingford's Hydrodynamics and Metocean Group Manager, said "SMARTtide is a key addition to our suite of advanced modelling tools, serving the wave and tidal energy industry around the coastline of the UK, Ireland, and northern France."

David Krohn, recent Wave and Tidal Development Manager at Renewable UK, talking about SMARTtide said "a welcome intervention to help marine energy developers with siting in order that the UK maximises its huge potential for tidal energy development."

HR Wallingford



[Click to view more info](#)

[Click to view video](#)

## SUSTAINABLE MARINE ENERGY STRENGTHENS TIDAL TEAM FOR PLAT-O PLATFORM

### ANDREW HUNT APPOINTED AS PRINCIPAL SUBSEA ENGINEER

Leading tidal energy developer Sustainable Marine Energy (SME) has appointed experienced marine renewables engineer Andrew Hunt as its Principal Subsea Engineer, as the company readies its innovative PLAT-O turbine platform for sea trials.

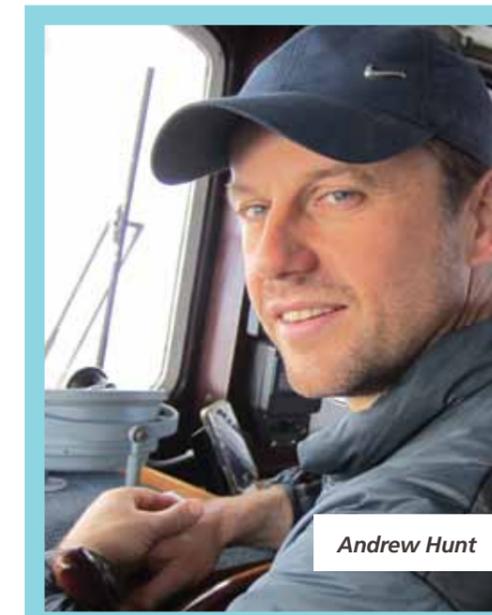
*"I know that I will be able to make a real contribution with the skills and experience I have acquired over many years of working in subsea engineering - building ROVs, cable ploughs and, in recent years, tidal turbines and connector management systems."*

Andrew's passion for all things marine extends out of the workplace as he is also a British Sub Aqua Club (first class) diver and national instructor, and he has been awarded the Diamond Jubilee Medal for his work as a Coastguard Rescue Officer.

### WEALTH OF EXPERIENCE

Jason Hayman, Managing Director of Sustainable Marine Energy, said "We are delighted that Andrew is joining SME."

*"He brings with him a wealth of experience, expertise, commitment and unique insights which will be very valuable to us as we complete the build of our PLAT-O platform and start performing sea trials this Spring."*



Andrew Hunt

After graduating in 1994 from Loughborough University, Andrew worked in the Aerospace industry for a major blue-chip company prior to moving to Newcastle upon Tyne to work for the world's leading independent subsea vehicle manufacturer - Soil Machine Dynamics.

Here he worked on all aspects of subsea vehicle design,

project management, manufacture, commissioning, test, installation and offshore work and has a great deal of subsea engineering experience with cable burial machines and work class ROVs.

After a short spell developing landmine clearing equipment for SMD's sister company PEL, Andrew returned to SMD to lead its marine renewables exploration with the TidEL project.

## BACKGROUND

Andrew has more than 16 years of subsea engineering experience and is a Chartered Engineer with a passion for making marine renewables a reality. He has played key roles in the development of a number of major marine projects.

Andrew commented; "I'm excited to be part of SME as it is a forward-thinking and pioneering company, and the whole team shares my strong passion for marine energy."

**Sustainable Marine Energy**

# MARINE ENERGY MATTERS

**Marine Energy Matters (MEM) is a strategic consultancy and business support organisation dedicated to the offshore renewables industry. Key activity areas include strategy and policy, project development, financial modelling and funding acquisition.**

The consultancy was founded in 2008 to support the global marine energy industry, with its founder Colin Cornish having gained early knowledge of the sector through his work within the Regional Development Agency and the development of the Wave Hub project. Since its inception, MEM has built an international reputation for helping the industry to develop and grow - born from involvement at the cutting edge of the sector.

## STRATEGIC ASSIGNMENTS

The organisation undertakes strategic assignments for governments and their departments, at national and local level, while private sector activity ranges from market entry and investor assistance through to project feasibility and development. Part of MEM's success results from the rapidly developing sector and the challenges it faces, not just from a technical perspective but also the need for new local, national and international policies to create a supportive development framework whilst ensuring protection for the natural environment and other groups that use it.



Image courtesy of: Marine Current Turbines - a Siemens business



## CONVENIENT LOCATION

Located in south west England, MEM has been intimately involved in the development of the marine energy sector, working with the public and private sectors including the South West Marine Energy Park, The Crown Estate, local government facilities such as Wave Hub and organisations wishing to establish a UK presence. A cornerstone of the organisation's activity

has been industry development across the prime offshore energy sectors – wind, wave and tidal – having helped develop local and national strategies through a number of strategic industry development/economic assignments.

## Marine Energy Matters

## ASSOCIATE EXPERTISE

MEM's associates have expertise across the spectrum of marine energy related fields from strategic industrial development (including economic, infrastructure and supply chain analysis) to specific project assessment and development. The consultancy's strategic knowledge is complimented by Geographic Information Systems (GIS), energy resource assessment and financial modelling capabilities.

# MARINE ENERGY TECHNICAL CONSULTING SINCE 1991

**IT Power has a long-standing history in the development of tidal stream and wave energy technologies which dates back to the early 1990s; this included some of the first studies and trials of tidal turbines and the first European-wide tidal resource assessment.**

For 12 years the company has developed their own technical designs, which culminated in the delivery of the Seaflow project and the spin-off off Marine Current Turbines in 2003. Since then, they have undertaken over 65 technical and strategic marine energy consulting projects across the globe and have seen the emergence of an exciting sector.

## WAVE & TIDAL SOLUTIONS

IT Power's passion for marine energy started through the development of their own solutions for tidal and wave energy exploitation. As more and more concepts started to emerge, they recognised the need for an experienced engineering consultancy able to provide technical support to entrepreneurs and academics developing marine energy technology. Contract R&D now provides the bulk of their workload.

The company's direct involvement in developing several technologies provided them with the knowledge to develop national roadmaps to governments around the world, as well as providing strategic advice to private companies wanting to enter the sector.

## CURRENT PROJECT SUPPORT SERVICES

Today, they still provide technology development services and strategy advice for private and public organisations; however, they have also built a team suited to providing project support services, due diligence reviews and feasibility studies.

As leading tidal and wave technologies look to large engineering firms for investment, the company has focused on strategic areas of the technologies that these organisations generally lack.

## PROJECT DEVELOPMENT

Private project developers are now stepping in to replace the utilities who are steadily withdrawing from the development of projects. These developers require the technical expertise of specialised consultancies to support their project work. The company has recently undertaken multiple projects looking to overcome the complexities associated with deploying infrastructure in aggressive marine environments.

## PARTNERSHIPS

IT Power work with a number of partners to complement their own abilities and through these partnerships, are able to offer assistance across all areas of the marine energy sector.

The company's specialist team is currently working on a number of marine energy projects including optimised vessels; design services; FEED studies; environmental scoping; hydrodynamic and tidal array modelling; mooring and foundations design, as well as lenders and owners engineer for project developers.

As the sector matures, the company aims to continue to provide valuable technical expertise in partnership with other capable organisations to deliver viable marine energy projects.

## IT Power



## INSURANCE & RISK MANAGEMENT

**As a leading global insurance broker and risk management consultant focusing on specialist lines business, wave and tidal is a key focus area for JLT Specialty Limited (JLTSL).**

### EXPERIENCE

Over the last five years their dedicated Renewable Energy Practice has worked closely with these rapidly growing and ever evolving industries, to develop innovative new risk management and insurance solutions at increasingly competitive prices.

The majority of their experience has been gained to date by working on UK wave and tidal devices and arrays/projects, however increasingly they are beginning to engage with this type of business in other countries and regions including; Canada, USA, Chile and Australasia.

### INDUSTRY SUPPORTING ROLE

JLT and the wider insurance community have a key role to play in supporting the continued growth of these industries. At present, insurance costs for such devices and projects represent some of the largest elements of their Capex and Opex expenditure, and moreover coverage is limited when compared to what is on offer for offshore wind devices and projects.

### BEST PRACTICE GUIDE TO WAVE AND TIDAL POWER RISK AND INSURANCE

The only way that this situation will continue to change is through closer co-operation and earlier engagement between the wave and tidal industries and the insurance industry. This is something JLTSL are keen to promote, as evidenced by the 'Best Practice Guide to Wave and Tidal Power Risk and Insurance' they co-produced with RenewableUK back in 2012 for these industries.

Specifically, the specialist insurance community can help these industries to improve risk management practices, contracting strategies and standards. All things being equal, this should lead to the benefits of lower insurance premiums and therefore lower cost of energy, as well as the provision of wider coverage and ultimately in the eyes of potential financiers a more 'bankable' investment.

### SPECIALIST HUBS

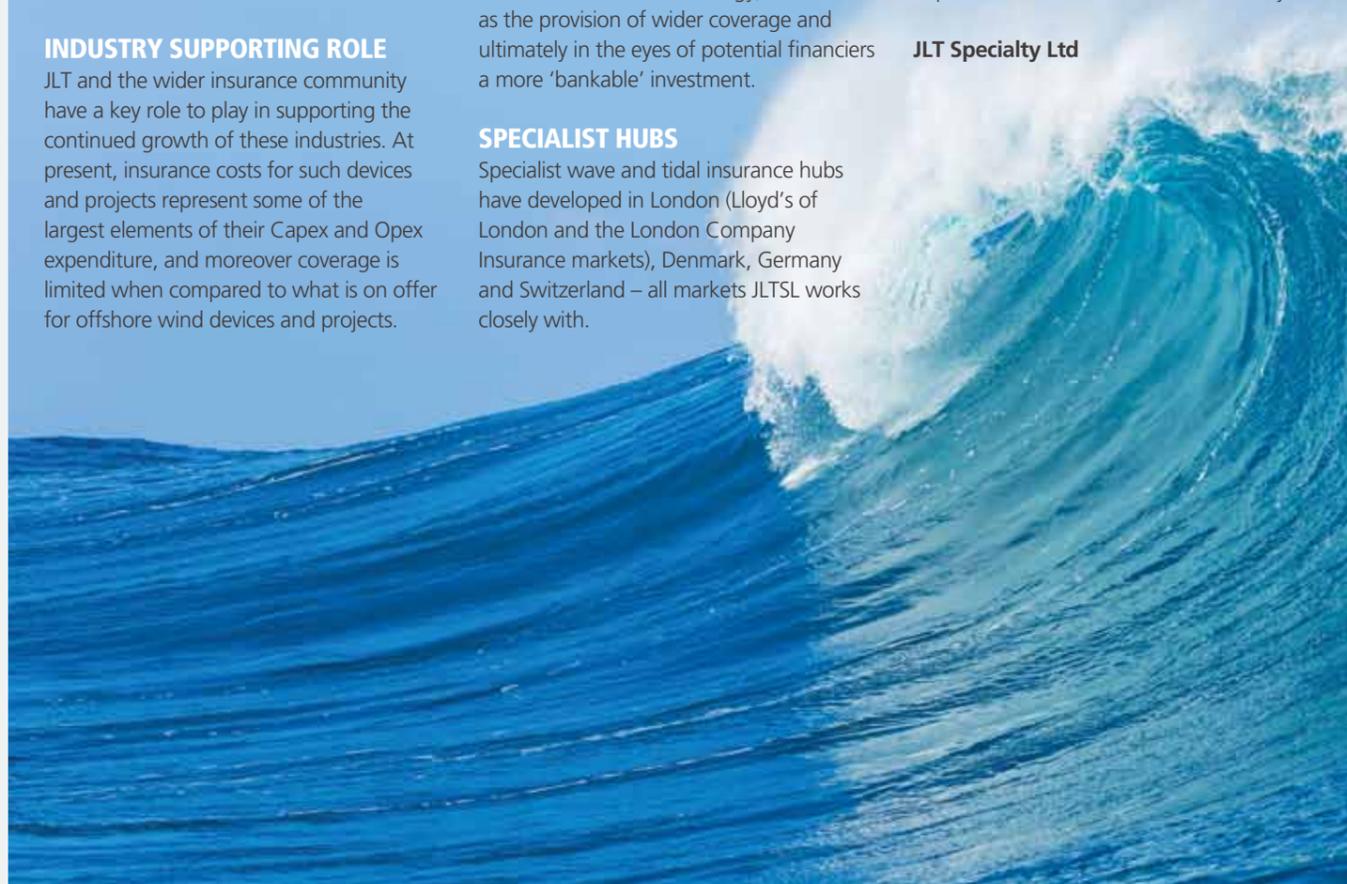
Specialist wave and tidal insurance hubs have developed in London (Lloyd's of London and the London Company Insurance markets), Denmark, Germany and Switzerland – all markets JLTSL works closely with.

Many of the insurers in these hubs are already leading the way in offshore wind project insurance; knowledge gained here being essential for the development of wave and tidal technology and arrays/projects too. For example, lessons learnt and on-going work being done to reduce the cost of cable losses in the offshore wind arena should benefit the first commercial wave and tidal arrays.

### FUTURE

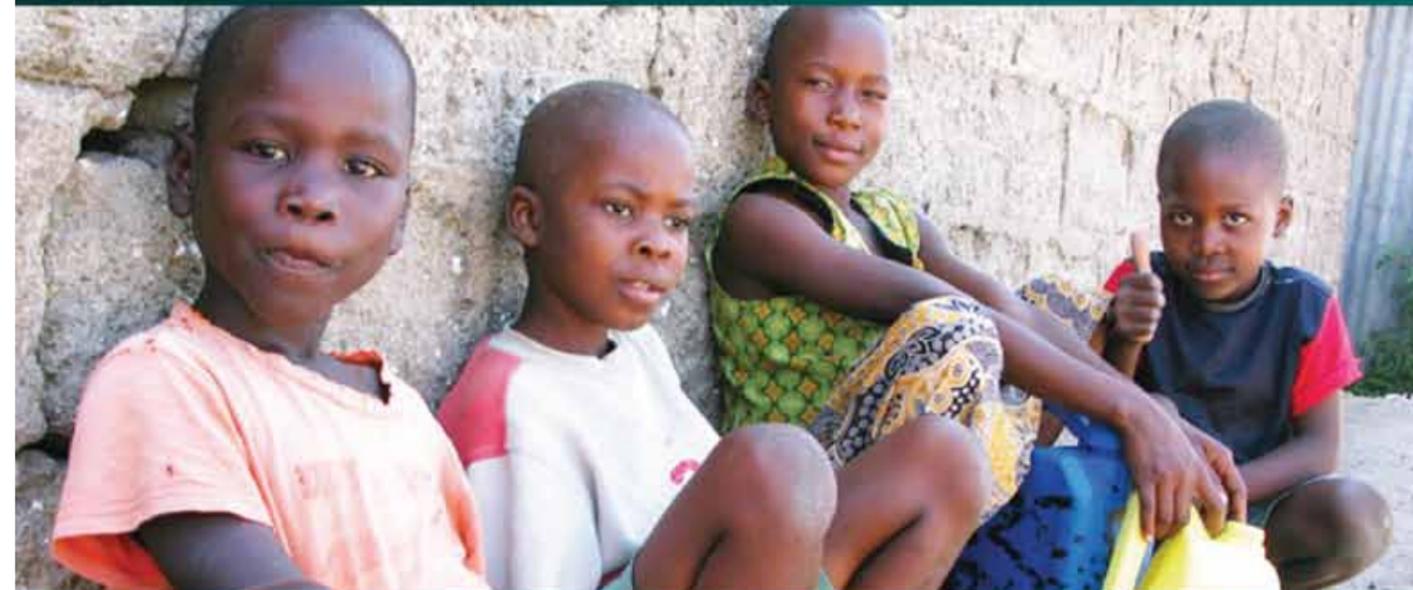
Looking forward, based on both the company's own experience and discussions with leading insurers in this area they believe that within the next five years wave and tidal gross premium will rise to approximately GBP 5,000,000 to 7,000,000 per annum, and therefore this type of business will continue to grow in importance for the insurance community.

**JLT Specialty Ltd**



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