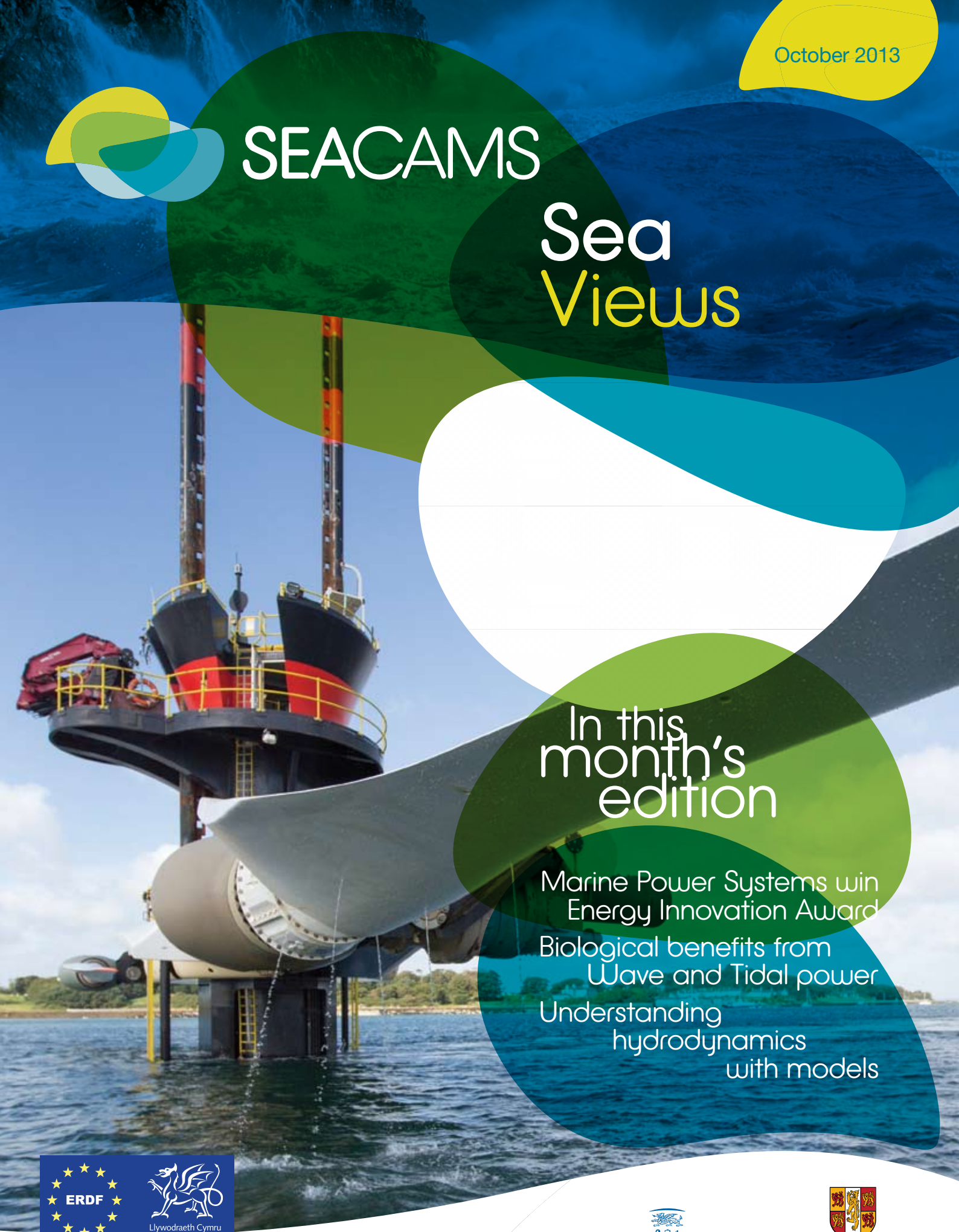
October 2013

SEACAMS Sea Views



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Marine Power Systems win Energy Innovation Award

SEACAMS has been working with Swansea–based Marine Power Systems who have won the EEEGR Innovation award 2013. In a hotly contested competition, their Wavesub device beat the other seven finalists to scoop the trophy.

Swansea-based Marine Power Systems (MPS) is developing a unique wave energy converter they are calling Wavesub. The design of their converter tackles four major challenges in the quest to harness wave power to deliver energy at very low cost. SEACAMS has been assisting Marine Power Systems by designing scale models to prove the concept of their innovative Wavesub device. Dr. Daryn Taylor from SEACAMS has been working closely with the company using sophisticated product design software that allows the model to be viewed from a range of different angles. In addition, assistance with scaling calculations ensure that models of the device can be produced to relevant scales for tank tests that will be used to refine operating efficiencies before full scale production.

MPS was founded in 2008 by Dr. Gareth Stockman and Dr. Graham Foster, both mechanical engineers, who had a vision for a low cost device that could harness the power of the waves. Dr. John Chapman joined the team as Design and Development Engineer to help take the concept to market.

"MPS has a wealth of experience in marine renewables and we recognise that harnessing wave energy has major potential as a sustainable energy source. This is because there is highly concentrated energy to be released from wave energy as it is formed by the effects of solar and wind energy," explains Gareth Stockman, MPS' Managing Director. "Think of wave energy as condensed wind energy that has been created by solar power. The power density of solar energy is at best 0.3 kW per m2 while wind delivers 0.5 kW per m2 compared to a whopping 2 to 3 kW per m2 from waves."

Wave energy also brings further advantages. Generated by wind interacting with the sea surface, friction between the air and the water creates waves. These turn into swells that can pass through water efficiently retaining their potential for energy to be harvested from them for thousands of miles. "The ability of waves to retain energy in this way means we are not reliant on local weather conditions to generate waves. A single storm somewhere in the Atlantic will generate swells that can be harnessed with the right device across the whole of Western Europe," confirms Gareth.

Capturing this energy efficiently and at low cost is where the real challenge lies and there are four major challenges that the award-winning Wavesub is designed to overcome. The first is to harness the sub-surface orbital energy flow. The water in a wave does not move in a straight line like a current. Instead the energy in a wave rolls through the water in a 'wave orbital'. The crest of the wave is the top of the wave orbit and the trough the bottom. "Our design uses a sub-surface float to capture the energy directly from the wave orbital under the water," reveals Gareth.

The other three key challenges are: the need to protect the device from severe weather conditions that may damage the device; the ability to deploy, recover and maintain the device easily and the ability to manufacture the device cheaply, relative to the energy it generates.

"Our work with SEACAMS putting together scale models of our device and testing it in-tank is an important process that has led to the rapid development of the device and small refinements in its design to optimise it further. The results have demonstrated proof of our concept and the benefits it brings to the industry. The Wavesub can operate at various depths protecting it from severe storms by operating underwater. The main body of the device acts as a transport and maintenance barge and the SEACAMS work has confirmed that its small size, simple shape and low structural loads will make this device exceedingly cost-effective to manufacture," confirms John.

> *"Wave energy is more concentrated than wind or solar"*

Reflecting on their award success, Dr Graham Foster, MPS technical director, said the WaveSub's success could not have been better timed as they sought investment for full-scale trials. "It's absolutely fantastic. Winning this award means so much more to a small business like ours. It could be 3-4 years before we are ready to go commercial when we hope the device will be bought and used by utility companies," he concludes.

Gareth Stockman and Graham Foster receive MPS' award

SEACAMS diver surveys biological diversity

Biological benefits from Wave and Tidal power

Tidal and wave energy renewable devices are approaching commercial realisation as sites are being determined and permissions granted to operate the first arrays of devices. Prior to selection of a site device manufacturers and operators are keen to understand the effect their devices will have on the habitat at the site and also how the habitat may affect the performance of the devices. SEACAMS has a wide range of biological expertise to bring to the market to support companies beyond the obligatory environmental impact assessment.

SEACAMS is offering marine tidal and wave energy companies based in Wales access to cutting edge technology and expertise to assess the effect of their devices on marine life. SEACAMS has already assisted many companies to understand the best sites for the deployment of arrays and are now able to support the assessment of arrays on the habitat in which they are deployed.

> *"Introducing arrays may benefit biological diversity"*

Dr. Ronan Roche is one of the nine scientists that make up the SEACAMS team with marine biology expertise. There are a number of key techniques that can be used to assess the marine habitat and the effect of introducing arrays on the biological populations at a site. These include deploying specialist scientific scuba divers; the use of video cameras towed on underwater sledges;

sophisticated sampling equipment and Remote Operating Vehicles (ROVs). "Many companies are keen to identify the effect of arrays of devices on the biological populations across the sites they are installed on and also the effect of changing population dynamics on their devices. While environmental impact assessments are legally required to achieve planning permission, companies in the sector are interested in longer term impacts," says Ronan.

> "Devices provide a hard substrate"

There are a range of changes that may affect the biological diversity of a site as arrays are deployed and many may be beneficial to the habitat they are in. "The first major benefit may be to fish stocks," suggests Ronan. "There is evidence that fish are likely to congregate among the arrays of tidal devices. The structures supporting the devices may provide shelter and will be free from fishing vessels. This is likely to lead to healthier fish stocks and rich fishing areas beyond the arrays as mature fish venture out from these areas to feed and mate."

While fish life is not likely to damage devices a range of other smaller life may affect operational performance. The devices themselves provide a hard substrate that could be colonised by organisms. "There are two potential implications to this, the first being that colonisation of the device may affect its operational efficiencies. The other is that devices may become a stepping stone for invasive species. Organisms such as sea-squirts, algae and various larvae may take up residence on the hard surfaces of the devices where before only soft substrates were present that are not favoured by these organisms," reveals Ronan.

The introduction of tidal and energy devices to harness the power of the sea providing a natural energy source is being delivered with consideration for the environment to provide a sustainable solution. The long term effects of arrays could also provide other benefits derived from changing the ecology of the sites at which they are deployed. SEACAMS scientists are keen to assess these benefits and ar beginning to develop projects with marine energy companies on the cusp of realising the commercial potential of this innovative energy generating technology.

Deploying technology to assess the environment

SeaGen tidal energy converters

Understanding hydrodynamics with models

The UK leads the world in wave and tidal energy with more devices installed than every other country put together. According to the Carbon Trust, marine energy has the potential to meet 15-20% of the UK's current electricity demand and there is increasing interest in the sector as the first generation of multi-device arrays are set to be delivered by 2017. SEACAMS is working with a number of wave and tidal companies helping them to maximise the operational efficiencies of their devices as they select sites and test their performance from single units to multiple arrays.

Wave and tidal devices are designed to operate within certain environmental parameters to ensure they generate power at optimum capacities. Finding appropriate sites that present the appropriate sea states, tidal flows and accessibility is important, together with testing of prototypes and the development of commercial scale arrays at these sites. SEACAMS modelling capabilities are helping marine companies to achieve this cost-effectively with the ability to accurately predict tidal currents, wave heights and other important parameters throughout the water column. "Initial work has supported companies wanting to understand how devices might operate at normal and extreme sea states in their region of interest, " explains Dr. Reza Hashemi, SEACAMS modeller.

Siemens-owned Marine Current Turbines (MCT) is developing large scale tidal current energy generation technology and is set to deliver the first tidal arrays in the UK. Its SeaGen tidal energy converters are to be used in the Skerries off the north west coast of Anglesey with consent in place for an array of up to 10MW installed capacity. This follows the successful demonstration of the first SeaGen device in Strangford Lough, Northern Ireland, operational since 2008. MCT has recently been working with the SEACAMS modelling team to understand the best sites for future development of marine energy farms. "Hydrodynamic modelling is invaluable as it can be used to rapidly identify the best sites to deliver the optimum performance from our tidal energy converters through

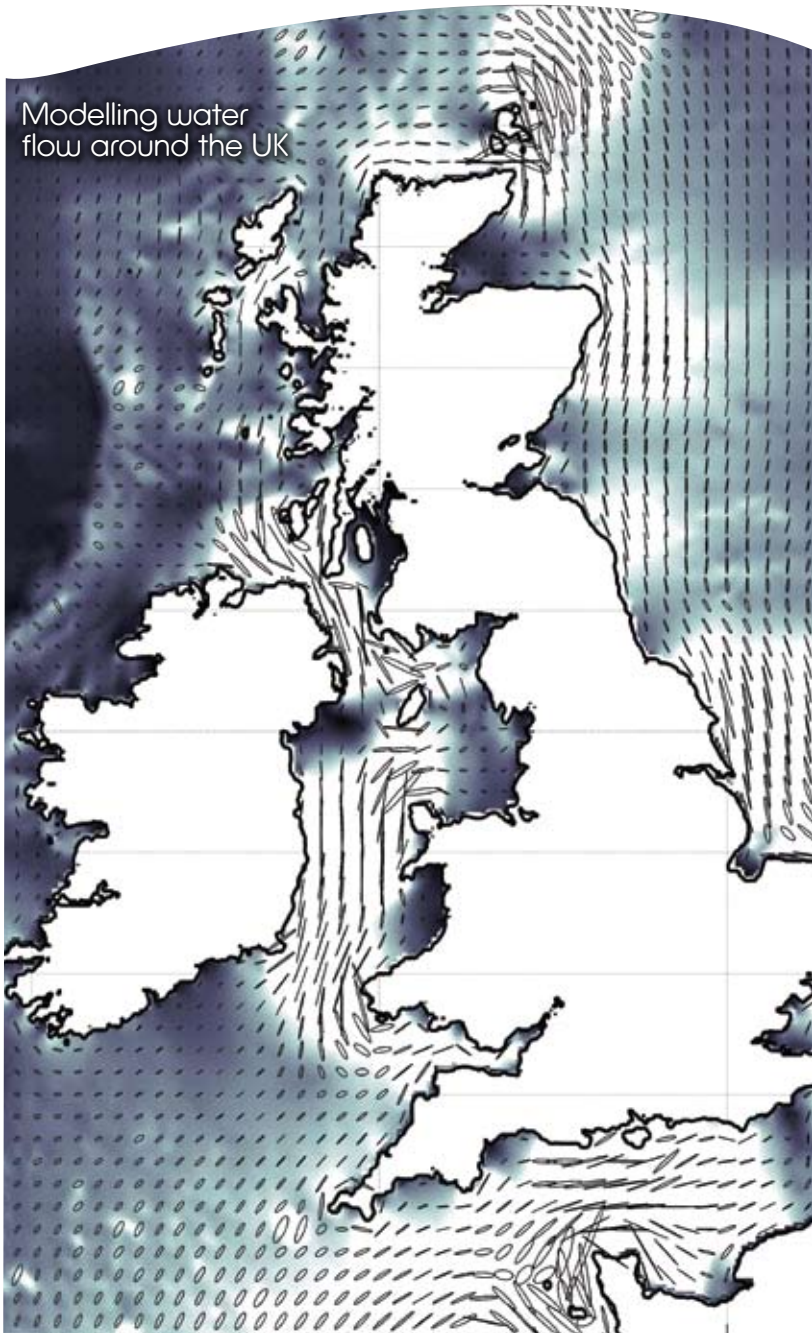
understanding more about the changing physical environment they will be operating in over long periods of time," reports Dr. Scott Couch, MCT Principal Resource Analyst.

> *"Models help refine operational performance"*

Numerical models are based on our understanding of the physical concepts of ocean mechanics and use computers to simulate those processes. We collect data at certain points on the site and use these to validate and tune our models. Numerical models are complex and require large quantities of processing power, as well as modelling expertise, which is often beyond the capability or affordability of a commercial SME. However the benefits of modelling are helping companies refine operational performance and ensure that devices survive extremes of sea state and operate efficiently in normal sea states. Importantly, as the industry moves towards commercialisation, the focus is moving from proving the efficient operation of single devices to scaling up the number of devices being operated at any one site. To generate sufficient electricity multiple devices need to be deployed as arrays.

SEACAMS is developing three-dimensional and coupled wave and tidal modelling tools and methodologies to examine variability of currents in the water column and how these change with the introduction of devices. "The continued development of three dimensional models is likely to impact on the way in which devices are positioned within an array. Not only will this predict natural variation in water velocity throughout the column, but also the impact devices in the array will have upon the surrounding environment," reflects Reza.

"When considering extreme conditions that impact upon the design and survivability of our technology, it is fundamental that we have the best possible understanding of the environment our devices will be operating in. The performance of existing predictive hydrodynamic modelling tools struggle to meet the accuracy constraints that are required to support robust engineering design, particularly when considering extreme events. It is therefore necessary during technology development to adopt what is potentially an overly conservative design approach. In order to support the drive to reduce the cost of emerging tidal technology, it is necessary to progress modelling tools beyond the current state-of-the-art. In areas such as the coupling of wave and tidal hydrodynamic models, SEACAMS is providing the step change in modelling capability required to accelerate the development of our industry," reflects Scott.

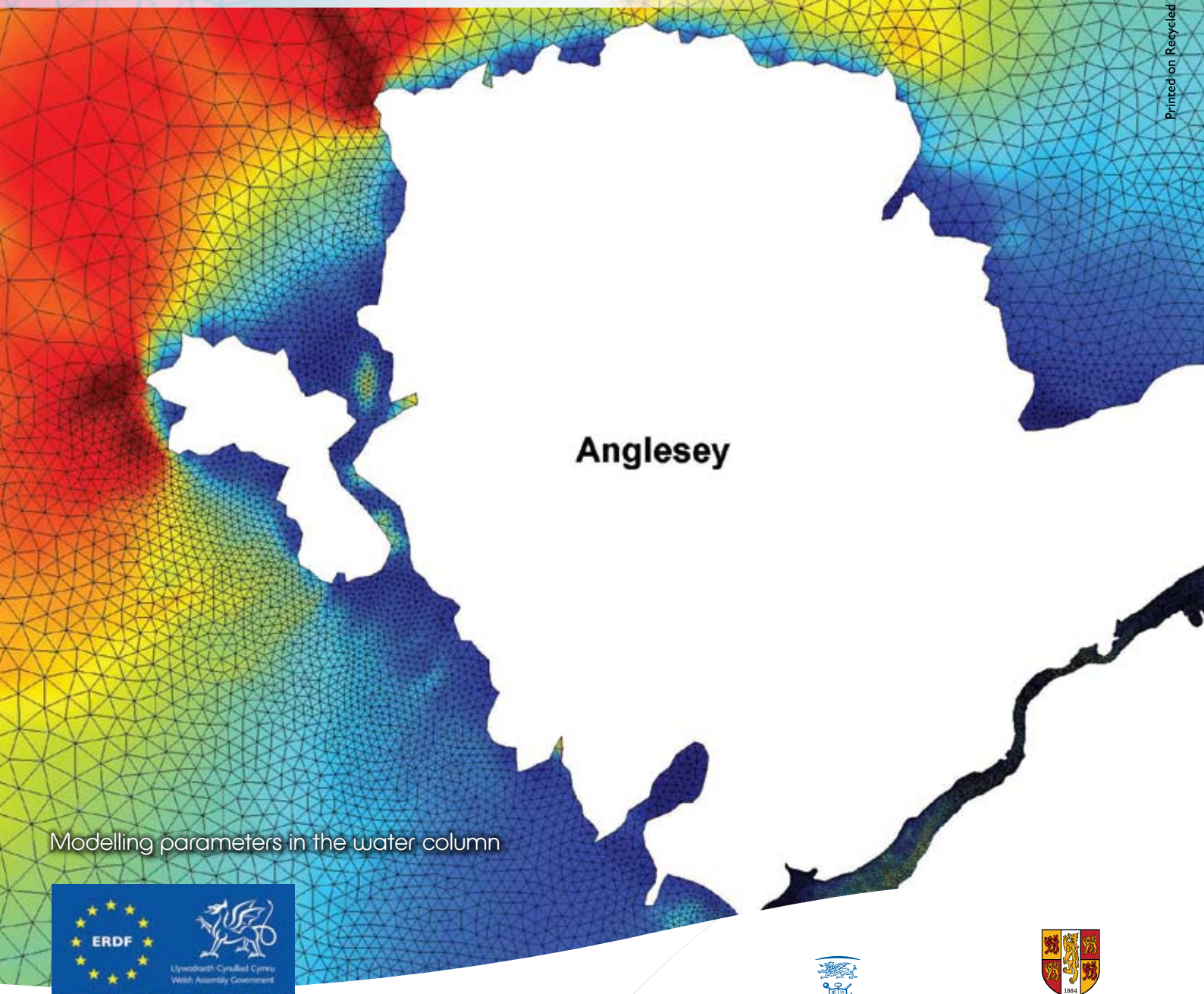


Modelling water flow around the UK

SEACAMS

SEACAMS offers businesses with interests in the marine sector access to the research, expertise and knowledge base of universities in Wales.

Tidal and wave technology is finally coming of age. "This important sector is moving from being a developing technology to commercial viability and will be able to deliver significant clean energy for the UK. It's important that these technologies are supported through development and early commercial testing to build market confidence and investment. Many of the players in this market are small and medium enterprises and the type of research support and academic expertise offered by the SEACAMS programme is very welcome in creating confidence in the technology and its bank-ability," concludes Dr. Stephanie Merry, Head of Marine at the Renewable Energy Association.



Modelling parameters in the water column

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